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THUJA ORIENTALIS AND JUNIPERUS CHINENSIS

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Plate 23

IN volume VII, page 71, of "The Journal of the Arnold Arboretum" issued in April 1926 an account is given of *Thuja orientalis* Linn. and the article is illustrated by a plate. The text deals faithfully with *T. orientalis* but the plate, unfortunately, represents *Juniperus chinensis* Linn. This picture was one of many supplied to us by an old and esteemed friend of the Arboretum and was published in good faith. On its appearance Mr. J. Hers, another valued correspondent of the Arboretum, wrote pointing out that the picture did not represent the Oriental Arborvitae but the Chinese Juniper. We then got other correspondents in China to take photographs of the real *T. orientalis* and send them to us together with herbarium material from the actual tree of which photographs were made. The correspondence has taken considerable time but at last we are able to publish a picture depicting a magnificent old *Thuja orientalis* and thus correct the error inadvertently made four years ago.

At a glance the two trees look very different but it must be stated that we have pictures showing the Juniper in habit almost identical with the Thuja. The principal difference apparent is the nature of the bark; in the Juniper it is gray and fissured, whereas in the Arborvitae it is dull brownish red, flaking off in thin, fibrous sheets. The branches on old trees of the Arborvitae are ascending and spreading, wheareas in the Juniper the most usual position is for them to spread horizontally. In the grounds of the Temple of Heaven at Peking, in Central Park, and in the grounds of other old temples and palaces both trees have been planted and planted long, long ago. The Juniper is the more common of the two but both are about equally esteemed by the Chinese.

The history given in our note on page 73, volume VII, of the Journal covers both trees but the size of the particular tree mentioned has reference to *J. chinensis*. According to Dr. TenBroeck, trees of *J. chinensis* in Central Park measure 47 feet 4 inches in height with a trunk 18 feet 9½ inches in girth at breast height and a crown spreading 48 feet. One in the Confucian Temple is 41 feet 10 inches in height with a trunk 16 feet 1 inch in girth and a crown spreading 45 feet 6 inches. Another in the grounds of the Temple of Heaven is 46 feet 7 inches in height with

a trunk 12 feet 6 inches in girth and a crown spreading 47 feet 8 inches. The tallest tree measured by Dr. TenBroeck is in Central Park and stands 51 feet 6 inches high with a trunk 14 feet 3 inches at breast height. The Thuja would appear to attain larger dimensions. That illustrated measures 57 feet tall with a girth of 21 feet. It is said to be over 600 years old and is growing in the Chungsan Park, Peking.

Both of these Conifers have long been known to cultivation in western lands, where both have given rise to polymorphous offspring much esteemed in horticulture. *J. chinensis* was known to Kaempfer and was also collected in China by J. Cunningham in 1701 as stated in Plukenet's "Amaltheum Botanicum," page 125 (1705). Linnaeus named it in his "Mantissa," page 127 (1767).

Although the Chinese Juniper is widely cultivated in China, being much planted in temple grounds and about graves, not once in my travels did I note a wild specimen. In many parts of Korea and Japan the dwarf growing *J. chinensis Sargentii* is common but the only place in which I have seen old trees of typical *J. chinensis* was on Dagelet Island in the Japan Sea; growing on the cliffs there and facing the full force of the sea were a number of fine old specimens. They were not tall, ranging from 20 to 35 feet in height with trunks 10 to 15 feet in girth and massive wide-spreading branches. They grow in humus filled cracks on the cliffs and must be of extreme age. The columnar habit of this tree is well known but like the Arborvitae when old age approaches its thinner branches are shed and a few of the thicker ones spread horizontally to form an open, widespreading, more or less rounded or flattened crown. Of course, close inspection of the two trees show wide differences not only in bark but especially in foliage and in fruit, but these are not obvious in a photograph.

THE SPREAD AND THE CONTROL OF PHACIDIUM BLIGHT IN SPRUCE PLANTATIONS

J. H. Faull

In an earlier paper on Phacidium Blight (J. H. Faull. A Fungus disease of Conifers related to the snow cover. Jour. Arnold Arb. x. 3–8. 1929) I dealt chiefly with its spread and control in the nurseries. Statistical observations and tests recorded therein showed that the spread of Phacidium Blight in the nursery is rapid if no preventive measures are employed, but that it can be fully controlled in seed beds and transplant lines by spraying with lime sulphur in the late fall. Corresponding data, though not as complete with respect to control, are now in hand relative to the blight in plantations.

1. Spread of the Disease

(a) *Spread in an affected plant*

That the blight invades masses of healthy foliage contiguous to those that are already affected can be convincingly inferred from casual inspections. Also it is quite plain from such that the spread is not continuously progressive in point of time, but that it is periodic; or in other words it is manifest that between successive advances there intervenes long intervals of time during which the blight is to all external appearances static. The regions last infected are characterized by a full foliage of unshrunken needles, bright, glaucous, or ashy brown (the shades and tints varying with the host species), with or without a few intermixed green ones. Those of the immediately preceding infection exhibit a greater or less defoliation and the needles that continue to adhere are whitened and shrivelled; while the needles that may still cling to the branches of regions infected at a yet earlier period are much bedraggled and soiled.

But in order to supplement circumstantial inference with direct demonstration, a large number of blighted Spruce trees in plantations were labelled and measured and the extension of the blight in them accurately noted for two successive years. At the same time data were assembled as to the rate and the times of extension of the disease, and for some of them the height-growth of the hosts. The observations made have shown conclusively that (1) the blight spreads to contiguous foliage, and (2) to the latter without regard to its age or location or orientation so long as the temperature of the air in the snow pockets is sufficiently high; that (3) the spread is under the melting snow in the spring only, with the elsewhere green foliage sharply and permanenly marked off during the succeeding summer from the adjoining browned masses; and that (4) the spread is to those parts only that are under the snow cover. It is not to be doubted that there could be a spread without the concomitancy of snow, provided that the surrounding atmosphere were maintained at the water-saturation point continuously for a sufficient length of time, that the temperature conditions were favorable to the growth of the fungus, and that the state of the host were such as to permit invasion of its leaves.

Complete data covering observations made in the springs of 1927 and 1928 on one group of twenty-two White Spruce trees are assembled in the subjoined table. These show that there was an average upward spread of the blight of almost four inches as against an average height-growth during the intervening summer of three inches. They also reveal the fact that in fifteen out of the twenty-two trees the blight had extended right to the terminal bud of the leader. These trees are marked by an asterisk (*).

Before leaving the subject of the extension of Phacidium Blight in individual trees it isi n place here to state that attempts have been made to find out whether or not there may be some spread through the stem, that is, whether or not the fungus causing the blight ever grows downward

Vertical upward spread of Phacidium Blight, and height growth in 22 White Spruce trees, planted Fall of 1924.

No.	Height; Spring, 1927	Height; Spring, 1928	Increase in Height	Upper Limit of Blight; Spring, 1927	Upper Limit of Blight; Spring, 1928	Increase of Blight
1	16 in.	21 in.	5 in.	9 in.	15 in.	6 in.
2	13	18	5	10	13	3
3	11	15	4	9	*15	6
4	17	19	2	14	*19	5
5	17	22	5	11	13	2
6	14	14	0	9	*14	5
7	10	12	2	10	11	1
8	15	17	2	13	13	0
9	10	13	3	8	*13	5
10	14	19	5	12	*19	7
11	12	15	3	12	*15	3
12	10	13	3	9	*13	4
13	11	13	2	11	*13	2
14	10	12	2	10	*12	2
15	13	15	2	11	*15	4
16	18	22	4	15	19	4
17	8	8	0	7	* 8	1
18	11	14	3	11	*14	3
19	10	14	4	9	*14	5
20	8	10	2	7	*10	3
21	14	19	5	10	18	8
22	12	15	3	9	*15	6
			Average 3.0 inches			Average 3.9 in.

through the bases of infected needles into the tissues of the stem, and thence upward into healthy needles by way of their bases. From what could be determined it would seem that the basal layers of cork prevent invasion by the hyphae through such routes. It is possible that there may be exceptions to this rule to be revealed by more persistent search, but so far none have been found. It is patent to anyone who has the slightest acquaintance with the disease that in general its spread is not by way of the stem; on the contrary it is everywhere apparent that it passes over directly to the green foliage of branches which happen to be pressed into contact with blighted ones by the weight of overlying snow or other means, or that have been inoculated with the reproductive elements of the blight-causing fungus. Moreover, the non-agressiveness of the causal organism after the spring thaws are past, up until the period of sporulation in the fall, affords indirect evidence that it does not invade healthy needles adjacent to diseased ones through the intervening stem.

(b) *Spread from affected plants*

Obviously it is important from the standpoint of control to become acquainted with the phenomena that characterize the dissemination of Phacidium Blight from plant to plant. In the earlier paper referred to

above, the subject matter of which was the blight in nurseries, emphasis was rightly placed on the importance of contagion. But there is also a dispersal by means of germs transported through the air; and for plantations, as we shall learn, these agencies are of relatively greater significance than that of contact.

We are now quite familiar with the remarkable contagious habit of the fungus (*Phacidium infestans*) that causes this blight. Its hyphae revive in the spring within the adhering, snow-buried needles that were infected many months previously, and there emerge from them through the stomata countless, most delicately spun, white, cobwebby mycelial threads that grow over, penetrate, and infect such green needles, without regard to the age of the latter, as lie in their path. Moreover, not only are individuals of the same species liable to contagion but also those of other species and genera. Thus the disease spreads by contact from White Spruce to Norway Spruce, Balsam Fir, White Pine, Banksian Pine, etc., and from Balsam Fir to White Spruce, White Pine, Hemlock, etc. In passing it may be stated that not all species of conifers are equally susceptible to blight, and some are apparently immune. Also there are most certainly two or more biological strains of *Phacidium infestans*, and these display a choice of specific hosts; or perhaps it is more accurate to say that a given coniferous species may be susceptible to one biological strain of *P. infestans* and more or less immune to another.

While contagion is of preponderate significance in epidemics of Phacidium Blight within nurseries it can be of secondary importance only in plantations. Naturally, in twice-transplanted or sub-plantation plots, where the little trees soon come into contact, essentially the same conditions favoring contagious spread prevail as in nursery beds or transplant lines. I have seen cases in certain nurseries in which under such circumstances blocks of White Spruce, Norway Spruce, Engelmann Spruce, and Colorado Blue Spruce, comprising numbers up to one hundred trees two to four feet in height, had been virtually ruined by the blight. But in ordinary plantations, whether on forest or park lands, by the time contact is established between neighboring trees their leaders are so well above the snow-level that contagion is restricted to lower branches, the loss of which is not of vital consequence. It need scarcely be pointed out that were there no other common means whereby the blight spreads, its prevention in plantations would follow from the choice of clean stock, always a sensible procedure, and sporadically diseased plants could be pulled by hand and destroyed or left alone in hope that their heads might push above the level of the winter snows ere their vitality had become exhausted.

But a sporulating fungus is the cause of Phacidium Blight, and as its spores germinate readily and abundantly it is certain that they must play some part in the spread of the blight. There are also produced large numbers of tiny, black granules (microsclerotia) of compacted mycelium

on the surfaces of blighted needles, easily displaceable by insects or birds or water; and they probably belong to the blight fungus. Though they have not yet been subjected to critical study it may be assumed that they, like other known microsclerotia, function as do spores. They are supplementary means of reproduction, capable of wide transport, and particularly resistant to drought or other unfavorable conditions. Consequently it could scarcely be otherwise than that frequent infections would result from spores and microsclerotia at points quite removed from their sources of origin and far beyond the confines of plants in contact.

While this conclusion is fully warranted, both on inferential and observational grounds, there has been much uncertainty as to the economic importance in plantations of these means of infection. Phacidium Blight is sometimes disastrously abundant in plantations, but our acquaintance with it in America has been so recent that wherever affected trees have been seen in plantations, in numbers no matter how large, one could never be certain whether or not they might have been diseased before leaving the nursery. The same would seem to apply to European experience with *Phacidium infestans* in Scots Pine plantations; widespread plantation losses have been reported from Scandanavia and Russia, but without reference to the subject of dissemination. The question has now been subjected to experimental inquiry, however, and an answer secured in exact, statistical form. One experiment was initiated by controlled inoculations in a blight-free plantation, and others, extending over periods of two and three years, were based on case studies of plantation plots in which some blight was present at the outset. A brief account follows.

I. The first experiment was one of unusual interest. It was located in an isolated plantation of Norway Spruce set out about 1922. The trees were from four to six feet in height and all were free from blight. Twelve trees whose crowns were quite separate from those of their neighbors were tagged, and bundles of Spruce twigs with blighted needles enclosed in mosquito-net bags about six inches in diameter, one to each tree, were tied in among the branches, close to the stem, and below the winter snow-level. This was done November 15, 1927, several weeks after the close of the growing season and just before the beginning of winter.

The following spring by the time the snow had melted away each bag was the center of heavy infection, the brown foliage of which was typically that of Phacidium Blight. The blighted needles were liberally sprinkled with microsclerotia and in the subsequent fall they bore an abundant crop of sporulating ascomata of *Phacidium infestans*.

The experiment was revisited in the spring of 1929, and at that time a remarkable phenomenon was witnessed. An examination showed that not only had the infection extended its limits on each inoculated tree, but that there were now thirty-nine newly infected trees, with browned masses of foliage measuring from three inches to a foot in diameter. Instead of twelve trees with blight as in 1928 there was now a circum-

scribed colony of fifty-one, and eleven of the former were plainly the centers from which the new infections had originated. The number of readily recognizable blighted trees was four and one-quarter times greater than it was one year previously, or an increase of 325%. The newly blighted trees were not in contact with the original twelve; but they were proximate to them and separated from them by distances of from three to twenty-three feet. In most cases they were within the limits of the eastern quadrants from the latter; evidently conditions for infection were favorable immediately following a transport of spores by wind from a westerly direction. The significance of all of this is enhanced by the fact that no other instances of blight had developed throughout the plantation.

The results of this experiment settle the question as to whether or not Phacidium Blight can be disseminated to an appreciable extent by means other than contagion, and they afford reason to more than suspect that there are strong possibilities of devastating spread in plantations. The data obtained from plantation plots next to be reviewed add strength to this presentation.

II. Six plantation plots were originally staked, but through misplaced zeal of an eradication crew and other causes data secured from four of them are incomplete. Observations on the two remaining plots, however, were continued over a period of three successive years. The results are clearly indicative of the potential seriousness of Phacidium Blight in plantations, though it is not possible to evaluate them with the same degree of exactitude as in Experiment I because of the fact that the disease was undoubtedly brought into the first of the plantations in question, and perhaps the second as well, from the nursery on an unknown number of transplants. At the time these plantations were set out the cause and the infectiousness of the blight were unrecognized, and so some plants were carried forward that otherwise would have been sprayed or destroyed.

Plot 1 measured 100 feet by 200 feet and contained 1020 White Spruce trees from seed of native origin, furrow planted in the fall of 1925.

Number of trees in the plot	1020
Blighted trees counted in the fall of 1927	313 or 30.7%
" " " " " spring of 1928	413 or 40.5%
" " " " " " " 1929	460 or 45.1%

Plot 2 measured 100 feet by 100 feet and contained 399 White Spruce trees from seed of Dakota origin, planted in 1922. There may or may not have been an inconspicuous amount of blight in the nursery at the time this plantation was set out. No one really knows. If there were any it had not yet attracted notice. This plot, however, was not beyond the reach of spores from other blighted plantations, with no obstacles between

to winds blowing from their direction; it is quite possible that the primary infection came from them.

Number of trees in the plot	399
Blighted trees counted in the fall of 1927	110 or 27.6%
" " " " " spring of 1928	166 or 41.6%
" " " " " " " 1929	237 or 59.4%

Limited as the observations are the conclusion is inescapable that the occurrence of Phacidium Blight in a young plantation is occasion for concern. Unquestionably its control in some plantations at least is imperative.

2. Control of the Disease

We have now had sufficient experience with Phacidium Blight in nurseries to know that control through dormant lime sulphur applied in the late fall is highly effective and entirely practical. We are not quite as far on with the problem in plantations, but some careful experimentation has been carried out, and the point has been about reached where we can speak with reasonable confidence of a successful issue. Attention was centered first on the nurseries, partly because control there was essential to their being, but partly because the elimination and prevention of blight in nurseries are fundamentally important for the plantations dependent on them for their stock.

Towards the solution of the problem European practice has had nothing to offer. Phacidium Blight is common and widespread in Scandinavia, Finland and Russia on Scots Pine (no other hosts are reported from Europe), and it is said to cause considerable losses in natural reproduction and in plantations. But so far European pathologists have made little progress towards effecting its control. On this side, insistence on finding a solution to the problem has largely come from the Forestry Department of the Laurentide Division of the Canada Power and Paper Corporation, and no inconsiderable share of whatever advance may have been made is due to the active backing and co-operation of the staff of that Department and their Chief, Mr. Ellwood Wilson. But before reviewing our experiments and observations brief reference should be made to two factors pertinent in a more general way to the subject of control, but none the less deeply significant, namely, heredity and climate.

The question has been repeatedly raised as to the rôle of heredity in control. The answer is two-sided, with the host on one side and the parasite on the other. It is a fact that species and genera of conifers do exhibit differences in inherent susceptibility towards Phacidium Blight, and some of them are practically immune. It is also true that there are indubitable biological strains or physiological species of *Phacidium infestans*, and these exhibit marked preferences in specific choice of hosts. Manifestly these are matters of great practical interest in dealing with

the blight; they will be discussed at another time. There is still another point. On the basis of our general knowledge of infectious diseases it is reasonable to assume that individual plants of White Spruce or other coniferous species are not equally susceptible to the blight fungus, of whatever strain; and there may yet be found some that are immune. But up to the present none of the latter have been recognized, and there are no known exact observations pertaining to the former. The establishment of immunity is an ideal consummation in combating infectious diseases, and presumably in this instance control might be possible by breeding for immunity. But certainly at this stage it would be fantastic to offer such a suggestion as a practical undertaking.

While the incidence of Phacidium Blight is primarily linked with the inherent susceptibility of the host species to the blight fungus, it is also very closely dependent on the environmental factor of climate. This becomes self-evident when it is recalled that the conditions essential to the development of the disease are, in addition to a certain dormancy of the host tissues, a high concentration of moisture in the atmosphere surrounding the foliage and temperatures at which the fungus will grow. These conditions are met in regions in which there is a continuous snow-cover throughout the winter and a prevalence of bright sunshine during the thawing period in the spring. With or without snow, where such conditions do not occur there is little likelihood of trouble from Phacidium Blight. There are still no doubt other factors that have a bearing on the occurrence of Phacidium Blight, and a knowledge of these might be helpful in tree growing or forest management and would throw light on the phenomena of its distribution with reference to the conifers in our native forests. But profitable discussion awaits the gathering of more data; so without further comment we pass directly to the subject of artificial control in plantations.

(a) *Prevention by use of stock from a healthy nursery*

Where Spruce trees are to be planted in regions in which there is a snow-cover throughout the winter it is fundamentally important that they be free from Phacidium Blight when they come from the nursery. The only way to be sure is to know that there is none of the disease in the nursery. Given clean stock to begin with, little or no trouble is likely to be experienced in the plantation.

(b) *Control by excision of branches with blighted needles*

An experiment to discover what control could be attained by the removal of blighted branches from diseased trees was begun in the fall of 1927. Twenty-five suitable trees were numbered and their blighted branches were cut off and burned. They were examined in the spring of 1928, and again in May, 1929. Up to the present nineteen out of the twenty-five have remained free of the disease; six have shown a continu-

ation of it. Either removal of blighted foliage from the latter was not complete, or there had been fresh infection from a spore discharge before the cutting was done. The blight persisted and progressed as it ordinarily does in other blighted trees throughout the plantation not included in the experiment.

Under the circumstances the results are as good as could have been expected. It is conceivable that in special cases, as in certain ornamental plantings, this method might be used. If so, it is essential that the pruning be thorough, and it is desirable to have it done in the spring—certainly at some time prior to the period of sporulation. This method has recently been recommended in Russia for the treatment of Phacidium-blighted plantations; just how economically feasible it might be there I do not know, but in America it would seem to be of very limited applicability.

(c) *Control by hand eradication of blighted trees*

This method was tried out during the summer of 1928 in a preliminary way on a scale involving a comparatively large acreage. On the greater part of the area of eradication the diseased trees were pulled by hand, and deposited at once in canvas bags; these in turn were emptied into a canvas-lined wagon-box, carted away and burned. Elsewhere the trees were older and too deeply rooted to be pulled easily. Their stems were cut off near the ground, and the crowns were hauled away and burned.

I inspected the experiment in May, 1929, and found that the results were fairly satisfactory where the trees had been pulled bodily, but a failure in the other instance. The cost was low and without objection from that point of view. Where the trees were cut off instead of being pulled, low-lying branches remained attached to the stumps and their foliage was almost invariably heavily blighted the following spring. In both cases additional trees developed blight in the spring of 1929. Either these had been overlooked by the eradicators the previous year or they were new outbreaks. Whatever the explanation may be, the necessity for further eradication remained. It so happens that I have some exact information on this point. One of my plantation plots was mistakenly included by the eradication crew in their work. In 1927 there were 373 trees in the plot, of which 77 were blighted. In the spring of 1928 the number of blighted trees had increased to 86. The crew eradicated from the plot in 1928, though how many plants they removed I cannot say. In the spring of 1929 I counted 18 blighted plants in the plot.

Where eradication is by hand it can be done most thoroughly in the spring. The affected plants stand out most prominently at that time, and if removed then they are out of the way before there is any dispersal of spores from them.

Aside from the fact that complete eradication is practically impossible in the operations of a single year, there is a presumptive objection in the

to the method that should be considered, namely, the gaps that remain. Whether or not they should be left unfilled would doubtless be contingent on their size, their frequency, and the costs of replanting. Of course if replanting be done the stand is no longer even-aged, but that might be a matter of minor consequence. On rough terrain hand eradication would appear to be one of the most practicable methods.

(d) *Control by spraying with lime sulphur*

Three tests of this method were carried out in 1928 in two widely separated districts, in the Province of Quebec and the State of Maine.

Experiment 1.

There were about 450 White Spruce trees, planted in 1925, in a staked plot. They were sprayed the latter part of October, 1928, with lime sulphur of 50% strength of a standard formula. The plantation all about the plot was heavily blighted, and there was an abundance of new blight in the spring of 1929. Within the sprayed plot there had been 232 blighted trees. Of these, in the spring of 1929, there were 11 plants only in which the blight obviously remained. There were 43 cases in which I could not decide with certainty whether or not the blight had been completely destroyed. In the remaining 178 trees the blight fungus was dead and it had made no further inroads on the foliage.

Experiment 2.

There were about 300 White Spruce trees, planted in 1923, in a staked plot 75 feet by 150 feet. They were sprayed the latter part of October, 1928, with lime sulphur of 50% dormant strength as in Experiment 1. The plantation all about the plot was heavily blighted, and there was an abundance of new blight in the spring of 1929. Within the sprayed plot there had been 105 blighted trees. Of these, in the spring of 1929, there were 3 plants only in which the blight obviously remained. There were 12 cases in which I could not decide with certainty whether or not the blight had been completely destroyed. In the remaining 90 trees the blight fungus was dead and it had made no further inroads on the foliage.

Experiment 3.

This test was carried out on twice-transplanted 8-year old Norway Spruces and 6-year old White Spruces. Lime sulphur of 75% dormant strength was applied in the fall of 1928.

In this experiment there were about 800 trees in all; they were in rows but with the crowns of the trees within each row in light contact. The blighted trees only, 115 in number, were sprayed. Inspection the following spring revealed the fact that in all of these without exception the old blight was killed by the lime sulphur and no new blight had developed. One surprising feature was the extensive development of new blight on the unsprayed trees. Five hundred and ninety-seven of them were now (spring of 1929) more or less conspicuously blighted; it is possible that

some of them had been touched with blight in the spring of 1928 but not enough to attract casual notice in the fall of that year.

The outcome of these experiments is very encouraging. In Experiments 1 and 2, where 50% lime sulphur was employed, all of the trees, healthy and diseased, were sprayed. Not a single new case of blight developed, and out of the original 337 blighted Spruces there was an undoubted persistence of the disease in 14 only. It is anticipated that the majority of the former will now establish themselves as permanent members of the plantation; practically all of them would have done so had they been treated before being so severely ravaged. In the third experiment, where 75% lime sulphur was used, blighted trees only were sprayed, 115 in all; the blight was destroyed in every one of them, and with few exceptions they will be merchantable. On the other hand an astonishingly large number of the unsprayed trees in the plot developed blight. All told, 452 blighted trees in the three experiments were sprayed; and living blight continued with certainty in but 3% of them.

Were plantation spraying to be carried out on a large scale, perfection is scarcely to be expected; but if the work is done properly at the proper time the failures are likely to be negligible. One general application, too, would probably be sufficient. It is needless to repeat that late fall is the only season in which spraying can hope to be effective. The 75% formula, dormant strength, is apparently about right for White and Norway Spruce.

(e) *Control by dusting*

Dusts are now being employed quite extensively for the control of various fungus diseases of fruit trees. Some think very highly of their efficacy and use them in preference to sprays; others are not so enthusiastic over them. It is possible that, aside from making the right choice of dust, the nature of the climate plays a part with respect to the quality of the results. If a dust be effective it has in its favor a much lower cost of labor, it can be applied much more quickly, and it is less disagreeable to handle. Dusts can also be used much more easily than sprays where the terrain is rough. Dusting for the control of Phacidium Blight is certainly worthy of careful trial.

(f) *Value of cover in control*

On this point I have nothing more to offer than an account of two casual observations.

One of my plantation plots grew up to a rank growth of coarse grass, so heavy, indeed, that the Spruces on the plot, planted in 1925, were much over-topped by the grass in both 1927 and 1928. It was so difficult finding the markers in the spring of 1929 that hope was abandoned of securing accurate data. But it seemed from what I could observe that the blight had not spread in that plot and that some of the plants had apparently been able to shake it off. If this be true the explanation is

to be sought in the shading from the sun in the spring, and the obstruction afforded by the grass to the spread of the spores in the fall.

The second instance that came to notice was that of two adjoining plantations of Spruces separated only by a wagon trail. In the one on the north side of the dividing road no cover was afforded, and blight in that plantation was markedly prevalent. The plantation to the south of the road was covered by a rank growth of weeds and grass, and the trees on it were remarkably free from blight. True, its soil was richer and better prepared, but the explanation for comparative freedom from blight is probably the cover. This is doubtless an important factor governing the distribution of Phacidium Blight in the native forests.

(g) *Constant watchfulness*

In conclusion let me reiterate that maintenance of a blight-free nursery is the first consideration. Then in regions liable to Phacidium Blight the young coniferous plantations should be inspected annually, preferably in the springtime, for the first few years of their existence—until the leaders get well above the snow-cover of winter. If sporadic cases of blight appear in them the diseased plants should be thoroughly sprayed with lime sulphur in the late fall, or pulled out by hand and burned. Just as Phacidium Blight can be economically controlled and prevented in nurseries, so too, I doubt not, can it be in the plantations.

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CHROMOSOMES AND PHYLOGENY IN CAPRIFOLIACEAE

KARL SAX AND D. A. KRIBS

Plate 24

The family Caprifoliaceae contains thirteen genera, most of which are distributed in the north temperate zone. *Lonicera* is the largest genus with about one hundred and eighty species while *Heptacodium*, *Linnaea* and *Kolkwitzia* are monotypic. The Arnold Arboretum contains representative species of eight genera, and in the larger genera both Asiatic and American forms are represented.

With the possible exception of *Sambucus* the family seems to be a natural one and taxonomists have generally agreed in the grouping of the various genera. There is, however, considerable variation in the degree of specialization of floral parts and in wood structure.

From the standpoint of the geneticist the family is of interest because of the occurrence of natural species hybrids in the genera *Sambucus*, *Viburnum*, *Symphoricarpus*, *Diervilla* and *Lonicera*. The family contains many of our most valuable ornamental shrubs and additional hybrids between certain species should be of considerable horticultural value.

A cytological study of the more important genera of Caprifoliaceae has

been made by the senior author to determine the chromosome number and size relationships. A study of wood structure has been made by the junior author in an attempt to determine the phylogenetic changes in structural specialization of these genera. Such studies should throw some light on the relation between chromosome variation and phylogenetic development in this family.

Chromosome counts were obtained from root tips of young plants in the greenhouse and from pollen mother cells of mature plants in the Arboretum. The pollen mother cells were smeared on a dry slide, fixed in Navaschin's solution for about 30 minutes and stained in crystal violet iodine. In some cases the young buds were fixed in absolute alcohol and acetic acid and later used for aceto-carmine preparations.

The taxonomic classification of sections and species of the various genera of Caprifoliaceae is based on Rehder's Manual (1).

The genus Sambucus contains about 20 species which are divided into two sections. Of the seven species described by Rehder three are of Asiatic or European origin while four are natives of North America. Chromosome counts have previously been obtained for *S. nigra* and *S. racemosa* (2). Both species have eighteen pairs of chromosomes. Permanent smears of the pollen mother cells of the American species *S. canadensis* show that this species also has eighteen gametic chromosomes. *Sambucus nigra* and *S. canadensis* belong to the section Eusambucus while *S. racemosa* belongs to the section Botryosambucus. The chromosome number is the same for both European and American species and in all cases the chromosomes are comparatively large. Somatic figures of *S. racemosa* have also been obtained from plants in the Arboretum greenhouses and the size and approximate number of the chromosomes are shown in figure 1. The average length of the chromosomes is about 4 microns.

There are nine sections and about 120 species in the genus *Viburnum*. Most of the species are natives of Asia, but the genus is well represented in North America. Representatives of six of the nine sections have been studied, including both Asiatic and American forms. The section, species, gametic chromosome number and native habitat are given as follows:

VIBURNUM

Section	Species	Chromosome No.	Origin
Lantana	V. Lantana	9	Europe-Asia
Pseudotinus	V. alnifolium	9	N. America
Pseudopulus	V. tomentosum	9	Japan-China
Lentago	V. Lentago	9	N. America
	V. prunifolium	9	N. America
Odontotinus	V. hupehense	9	China
	V. acerifolium	9	N. America
	V. lobophyllum	9	China
Opulus	V. trilobum	9	N. America
	V. Opulus	9	Europe-Asia
	V. Sargenti	9	N. E. Asia

All of the Viburnum species investigated have nine pairs of chromosomes. The chromosomes of this genus are relatively large. The somatic chromosomes of *V. Opulus* are shown in figure 2. The average length of these chromosomes is about five microns.

Only one species of *Symphoricarpus* has been investigated although the genus contains about sixteen species, which with one exception are natives of North America. There are eighteen somatic chromosomes in *S. orbiculatus*. They are relatively small and slender and have an average length of approximately 1.5 microns (Fig. 3). *Symphoricarpus albus* is probably a hexaploid form but exact counts could not be obtained.

Abelia contains two sections and about twenty-eight species, most of which are natives of Asia. Chromosome counts of *A. Engleriana* were obtained from pollen mother cells. The gametic number is sixteen. Somatic chromosomes of *A. Schumannii* were also obtained and although an exact count could not be obtained it is probable that the number is thirty-two. The chromosomes are very small and have an average length of less than one micron (Fig. 4).

Kolkwitzia is a monotypic genus from China. In *K. amabilis* there are sixteen pairs of chromosomes. The somatic chromosomes are similar to those of *Abelia* but are somewhat larger (Fig. 5).

The genus *Diervilla* is divided into three sections and about twelve species. Of the ten species described by Rehder, three are of American origin while seven are natives of Eastern Asia. Species hybrids exist only in the Weigela section.

Chromosome counts have been obtained for three species in the Weigela section and for two species in the Eudiervilla section. There are eighteen pairs of chromosomes in the Asiatic species *D. praecox*, *D. florida* and *D. horiensis* and in the American species *D. sessilifolia* and *D. rivularis*. The somatic chromosomes of *D. hortensis* are shown in figure 6. The chromosomes are quite small and average only a little more than a micron in length.

The genus *Lonicera* is the most important one in the Caprifoliaceae. It contains two subgenera of which one is divided into four sections and about 180 species. Most of the species are natives of North America. Many species hybrids are described by Rehder, but no hybrids are known between species of different subgenera or sections of the genus.

Chromosome counts have been obtained for representative species of the genus. The species investigated include both subgenera, all sections, and both American and Asiatic forms. The subgenera, section, species, number of gametic chromosomes and native habitat of the species follow on page 150.

The chromosomes of *Lonicera* are rather small and have an average length of about 2 microns. The somatic chromosomes of *L. chrysantha* are shown in figure 7. In many cases trabants could be seen but they were not present in all species probably due to difference in fixing and staining.

LONICERA

Section	Species	Chromosome No.	Habitat
Subgenus 1. Chamaecerasus			
1. Isoxylosteum	L. thibetica	9–18	China
2. Isika	L. microphylla	18	E. Asia
	L. coerulea	9–18	Europe, Asia
	L. tenuipes	18	Japan
	L. fragrantissima	9	China
	L. Altmannii	9	Turkestan
	L. Ferdinandi	9	China
	L. orientalis	9	Asia Minor
3. Coeloxylosteum	L. Korolkowii	9	Turkestan
	L. tatarica	9	Russia–E. Asia
	L. chrysantha	9	N. E. Asia
	L. demissa	9	Japan
	L. Maackii	9	China
	L. prostrata	9	China
	L. quinquelocularis	9	Himalayas
4. Nintooa	L. Henryi	27	China
	L. alseuosmoides	18	China
	L. japonica	9	E. Asia
Subgenus 2. Periclymenum			
	L. dioeca	9	N. America
	L. prolifera	9	N. America

In the hexaploid species *L. Henryi* the chromosomes are about the same size as those of the diploid forms (Fig. 8).

Most of the species of *Lonicera* examined have nine pairs of chromosomes. The tetraploid and hexaploid species have probably originated through chromosome duplication since both diploid and tetraploid forms are occasionally found in the same species, and the hexaploid *L. Henryi* resembles the tetraploid species *L. alseuosmoides*. In no case is there any evidence of species formation by crossing of diploid with tetraploid forms. Polyploidy has apparently been of little importance in species formation in *Lonicera*.

Species with nine (9) gametic chromosomes are found in both subgenera and all sections of *Lonicera* but species hybrids are known only between species of the same section. During the past summer crosses were made between sections and subgenera but no seeds were obtained.

The chromosome numbers found in the genera of Caprifoliaceae suggest that nine is the basic number for the family, although *Abelia* and *Kolkwitzia* with sixteen gametic chromosomes do not agree with this interpretation, unless they are tetraploids which have lost two pairs of chromosomes. *Sambucus* and *Diervilla* have eighteen pairs of chromosomes while *Viburnum*, *Symphoricarpus* and *Lonicera* have nine chromosomes as the basic number. In view of the occurrence of polyploidy in *Lonicera*, and probably also in *Symphoricarpus*, it seems possible that *Sambucus* and *Diervilla* are tetraploid forms with nine chromosomes as the original basic number.

Variation in chromosome size is much more striking than variations in chromosome number. *Sambucus* and *Viburnum* have relatively large

Chromosome number in Caprifoliaceae

chromosomes. The chromosomes of *Lonicera* are about half the length of those of *Sambucus* while the chromosomes of *Diervilla, Kolkwitzia* and *Abelia* are only about one-fourth as long as those of *Sambucus* and *Viburnum*. In volume the chromosomes of *Sambucus* and *Viburnum* are from twenty to forty times as large as those of *Abelia* and *Kolkwitzia*.

In *Lonicera* there is no great difference in the size of chromosomes in different species although those of the hexaploid *Henryi* are somewhat smaller than those of the diploid forms. In some genera, such as *Carex* there is considerable decrease in chromosome size as the numbers increase due apparently to the inability of the nucleus to produce more than a certain amount of chromation. Even where the chromosome number is the same, there may be considerable variation in size of chromosomes of related species.

WOOD STRUCTURE

In the primitive vascular plants, the secondary xylem is composed of tracheary elements of a single general type, the so-called tracheids. This type of wood has persisted in certain Dicotyledonous genera and a remarkably complete record of the evolution and differentiation of more complex types of tracheary tissue is preserved in the xylem of other living representatives of the Dicotyledons. The evidence is so comprehensive that it is possible to arrange the wood of Dicotyledons in a phylogenetic sequence of increasing structural specialization. When this is done it becomes evident that the evolutionary modification of the stem does not usually parallel that of the flower and leaf.

From the standpoint of wood structure the Caprifoliaceae contain primitive, specialized and transitional genera.

The genera with relatively primitive wood structure include *Viburnum, Diervilla,* and *Kolkwitzia*. *Abelia, Symphoricarpus* and *Lonicera* are intermediate or transitional in structural specialization, while *Sambucus* is highly specialized.

The genus *Lonicera* is a transitional form. The species with more primitive vascular structure include *L. coerula, Maackii, fragrantissima, prolifera* and *tenuipes*. The more specialized species include *L. dioica, Henryi, thibetica, chrysantha, tatarica* and *alseuosmoides*.

It is evident that specialization in wood structure does not parallel floral specialization since *Sambucus* with highly specialized wood structure is the most simple and primitive in floral development.

It is also clear that there is no correlation between either chromosome number or size with the degree of vascular specialization in the Caprifoliaceae. The following table will simplify comparisons.

There is more or less variation in wood specialization in the genus *Lonicera*, but there is little or no relation between degree of specialization and chromosome number of the various species. Since polyploidy is probably of little significance in species formation in *Lonicera* little or no correlation would be expected between chromosome number and morphological characters.

Genus	Chromosome number	Chromosome size[1]	Wood Structure	Number of species
Sambucus	18	2.00	specialized	20
Viburnum	9	1.25	primitive	120
Symphoricarpus	9	.14	intermediate	15
Abelia	16	.05	intermediate	28
Kolkwitzia	16	.09	primitive	1
Diervilla	18	.20	primitive	12
Lonicera	9–18–27	.50	intermediate	180

[1] Approximate volume in cubic microns.

The age and area hypothesis is probably of little value in determining the relationship between the different genera of Caprifoliaceae. *Viburnum* is widely distributed in Europe, Asia and North America and is probably an old genus as indicated by fossil remains and wood structure. *Lonicera*, however, contains more species and is just as widely distributed as *Viburnum*, but is much more specialized in vascular anatomy. *Abelia* might appear to be a relatively young genus since most of the species are found only in Asia, but the presence of two species in Mexico indicated a wide distribution at some time in the past. Since most genera are most abundant in Asia and certain genera are found only in China, it would seem probable that the family is of Asiatic origin. *Symphoricarpus*, however, is represented by only one species of very limited distribution in China; the other species are all natives of North America. Does this mean that the genus is so old that the original Oriental forms have disappeared and only the newer American species remain?

Neither wood structure nor geographic distribution offers any clear indication of the phylogenetic development in the family Caprifoliaceae. It appears that differentiation of genera has been associated with changes in chromosome size, and that changes in chromosome number are probably of minor significance.

SUMMARY

1. The gametic chromosome number in the Caprifoliaceae has been determined as follows: Sambucus 18, Viburnum 9, Symphoricarpus 9, Abelia 16, Kolkwitzia 16, Diervilla 9, and Lonicera 9, 18 and 27.

2. The chromosomes of different genera may vary greatly in size.

3. There is no correlation between either chromosome number or chromosome size and the amount of vascular specialization of the genera in this family.

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1. Rehder, A. (1927). Manual of Cultivated Trees and Shrubs. McMillan Co., New York, 930 pp.
2. Tischler, G. (1926). Pflanzliche Chromosomen-Zahlen. *Tabulae Biologicae* 4: 1–83.

DESCRIPTION OF PLATE

All figures are from somatic chromosomes obtained in root tips.

Fig. 1. Sambucus racemosa.
Fig. 2. Viburnum Opulus.

Fig. 3. Symphoricarpus orbiculatus.
Fig. 4. Abelia Schumannii.
Fig. 5. Kolkwitzia amabilis.
Fig. 6. Diervilla hortensis
Fig. 7. Lonicera chrysantha.
Fig. 8. Lonicera Henryi.

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NEW SPECIES, VARIETIES AND COMBINATIONS FROM THE HERBARIUM AND THE COLLECTIONS OF THE ARNOLD ARBORETUM[1]

ALFRED REHDER

Rhapis excelsa (Thbg.) Henry in litt., comb. nov.

Chamaerops excelsa Thunberg, Fl. Jap. 130 (1784).—Non Martius.

Rhapis flabelliformis L'Héritier apud Aiton, Hort. Kew. III. 473 (1789).—Willdenow, Spec. Pl. IV. 1093 (1806).—Sims in Bot. Mag. XXXIII. t. 1371 (1811).—Martius, Hist. Nat. Palm. III. 253, t. 144 (1849).

Trachycarpus excelsus H. Wendand in Jour. Soc. Bot. France, VIII. 429 (1861), quoad syn. *Chamaerops excelsa* Thunb., non *C. excelsa* Martius.

Though Martius, when describing a Japanese species of *Chamaerops*, adopted Thunberg's name for that species, he was nevertheless aware, as his citations and remarks show, that Thunberg understood under the name *C. excelsa* the plant published later as *Rhapis flabelliformis* by Aiton. The type specimens in Thunberg's herbarium of which I have photographs before me represent *Rhapis* and his description is clearly based on these specimens. Only Kaempfer's synonyms "Siguro et Sodio" which he cites under α), and "Soo Tsiku, vulgo Sjuro Tsiku" which he cites under β) do not belong here. The former represents *Trachycarpus* and the latter *Rhapis humilis* Bl. Thunberg's *C. excelsa* must obviously be considered as resting on his description and on the type specimens in his herbarium and not on Kaempfer's names cited as synonyms. The name *Chamaerops excelsa* Thunb. was by Aiton and later authors up to 1849 correctly referred to *Rhapis* and cited as a synonym of *Rhapis flabelliformis*, but in 1849 Martius in his Historia Naturalis Palmarum for the reason that the Japanese synonym "Sjuro et Sodio" represented it gave Thunberg's name to a plant later referred by Wendland to *Trachycarpus*. This view, however, can hardly be upheld and, as *Chamaerops excelsa* is the oldest name for the plant described as *Rhapis flabelliformis*, the specific name according to our rules of nomenclature, must be transferred to *Rhapis*.

In publishing the combination *R. excelsa* I am fulfilling a wish of the late Dr. A. Henry, who requested me in his letter of October 31, 1929, to publish this combination in the Journal of the Arnold Arboretum.

The plant described by Martius as *Chamaerops excelsa* and transferred by Wendland to *Trachycarpus* is apparently conspecific with *T. Fortunei*

[1] Continued from vol. X. 136.

Wendl. (*Chamaerops Fortunei* Hook.), though it may be distinguished as a variety. Whether it is identical with *C. Fortunei* var. *surculosa* Henry (in Elwes & Henry, Trees Gr. Brit. & Irel. VII. 1691 [1913]) I am not prepared to say. If considered specifically distinct it should receive a new name.

Carpinus mollis, sp. nov.

Arbor circiter 9-metralis ramulis gracilibus novellis minute tomentellis et sparse pilosis, robustioribus glabratis, annotinis glabris brunneis vel griseo-brunneis; gemmae oblongae, perulis obtusis minute ciliolatis ceterum glabris. Folia ovato-oblonga, 5–8 cm. longa et 3–4.5 cm. lata, basi cordata vel subcordata, acuminata, duplicato-serrata dentibus aristato-mucronatis, supra glabra, subtus tota facie molliter villoso-pilosa, densius ad costam et nervos, nervis utrinsecus 12–16 supra impressis subtus elevatis; petioli 6–14 mm. longi, breviter villoso-pilosi pilis longioribus intermixtis. Inflorescentiae fructiferae densiflorae cylindricae, pedunculo 1.5–2 cm. longo excluso 5–7 cm. longae et circiter 2 cm. diametientes; pedunculus et rhachis dense villoso-pilosa; bracteae stipitatae, oblique ovato-ellipticae vel ovato-oblongae, circiter 2 cm. longae et 8–10 mm. latae, acutae, 3–5-costatae, acute dentatae, latere interiore ad basin lobo suborbiculari inflexo et nuculam obtegente instructo, latere exteriore fere recto inflexo et nuculam et lobum interiorem partim tegente; nuculae cylindrico-ellipsoideae, circiter 5 mm. longae et 2.5 diametientes, glabrae.

CHINA. S z e c h u a n : Sungpan hsien, side of stream, *W. P. Fang*, no. 4245, August 17, 1928 (tree about 9 m.)

This new species is closely related to *C. cordata* Bl. and its var. *chinensis* Fr., but is easily distinguished by smaller leaves with less numerous veins and dense soft pubescence beneath, narrower fruiting catkins and smaller bracts. Besides by this new species the section *Distegocarpus* of *Carpinus* is represented in China by the following species: *C. cordata* Bl. var. *chinensis* Fr., *C. Wilsoniana* Hu and *C. Fangiana* Hu, of which the last two are remarkable for their very long fruiting catkins which measure 20–30 cm. in length, also the leaves are very large attaining 18 cm. in length.

Castanea mollissima Blume, Mus. Bot. Lugd.-Bat. I. 286 (1850).—Schneider, Ill. Handb. Laubholzk. I. 899, fig. 563, c–d (1906).—Seemen in Bot. Jahrb. XXIX. 288 (1900).—Rehder in Bailey, Stand. Cycl. Hort. II. 682 (1914); Man. Cult. Trees Shrubs, 159 (1927).—Nakai in Tokyo Bot. Mag. XXIX. 54 (1915).—Rehder & Wilson in Sargent, Pl. Wilson. III. 192 (1916).

Castanea pumila Blume, Bijdr. 525 (1925).—Non Michaux.

Castanea vesca Bunge in Mém. Div. Sav. Acad. St. Pétersb. II. 137 (Enum. Pl. Chin. Bor. 62) (1833).—Non Gaertner.

Castanea Bungeana Blume, Mus. Bot. Lugd.-Bat. I. 284 (1850).—Nakai in Tokyo Bot. Mag. XXIX. 54 (1915); XL. 585 (1926).—Handel-Mazzetti, Symb. Sin. VII. 27 (1929).

Castanea sativa var. *formosana* Hayata in Jour. Coll. Sci. Tokyo, xxx. art. I. 304 (1911).

Castanea formosana Hayata, Gen. Ind. Fl. Formos. 71 (1917).—Makino & Nemoto, Fl. Jap. 1090 (1925).

For further citation of synonyms and literature see Rehder & Wilson in Sargent, Pl. Wilson. III. 192 (1916).

Though Blume in 1850 recognized the specific difference of the Chinese Chestnut, none of the later botanists followed him, until O. von Seemen in 1900 took up Blume's name *Castanea mollissima* for the Chestnut of Central China. Seemen, however, laying great stress on the very variable pubescence of this species referred some specimens from Northern China to typical *C. sativa* overlooking the much more reliable character of absence or presence of glands on the under side of the leaves. After having examined in 1911 Blume's type specimen in the Rijks Herbarium at Leyden I followed Seemen in accepting Blume's name *C. mollissima* for the common Chinese Chestnut. In 1926, however, Nakai after having examined the type specimens in Leyden of *C. Bungeana* and *C. mollissima* states that the leaves of the latter are tomentose beneath with simple erect hairs. It is true that in the type specimen of *C. mollissima* which I re-examined in 1928 when in Leyden most of the hairs chiefly those borne on the veins and veinlets are simple, but fascicled hairs are present on the parenchyma, scattered on the older lower leaves, more plentifully on the younger leaves. Leaves with similar pubescence can also be found on Chinese specimens as in Meyer's no. 1400a from Ya tze ko, southwest of Sian fu, Shensi, collected Sept. 2, 1914. These simple pilose hairs are characteristic for *C. mollissima*, they are sometimes only sparingly present on the young tips of branchlets, but usually they are more copious and spread often from the branchlets to the petioles, and the midrib, veins and even veinlets of the under side of the leaves. In most specimens of *C. mollissima* the under side of the leaves is densely clothed with a white tomentum of felted fascicled hairs with or without simple hairs on the veins, but sometimes the leaves are glabrescent or quite glabrous. In the absence of simple pilose hairs *C. mollissima* can always be distinguished from the similar *C. sativa* Mill and *C. crenata* Sieb. & Zucc., which both vary with leaves quite glabrous and densely felted beneath, by the absence of glands on the under side of the leaves.

Castanea mollissima and *C. Bungeana* I consider extreme forms of the same species, the first characterized by the presence of copious simple hairs on the branchlets, petioles and under side of the leaves and the second by the absence of simple hairs from the leaves and petioles and a closer and finer white tomentum of felted fascicled hairs which occasionally may disappear entirely and leave the leaves quite glabrous. The branchlets are never quite glabrous, but either more or less villous at least at the apex or bearing scattered pilose hairs or both. I have before me more than 90 specimens from almost all provinces of China, also from Korea and Sikkim, which show all intergradations in pubescence. The most common is the form named *C. Bungeana* by Blume and those

botanists who recognize priority of position will have to give precedence to this name which appears two pages ahead of *C. mollissima*, but according to the International Rules of Nomenclature the name *C. mollissima* should be accepted since it was selected by Seemen as the name for that particular species, though he did not cite *C. Bungeana* Bl. as a synonym.

Lithocarpus brunnea, sp. nov.

Arbor 20-metralis, glabra, ramulis gracilibus, annotinis nigro-fuscis; gemmae terminales parvae, globoso-ovoideae, obtusae. Folia coriacea, graciliter petiolata, elliptico-ovata vel ovata, 4.5–9 cm. longa, basi late cuneata, lamina non vel vix decurrente, abrupte breviter acuminata acumine obtuso vel acutiusculo, integra, supra lucidula, subtus paullo pallidiora, primo intuito glabra sed indumento tenui crustaceo obtecta, costa media supra plana subtus elevata, nervis utrinsecus 6–9 supra fere planis vel levissime elevatis subtus elevatis, venulis trabecularibus supra tantum leviter visibilibus subtus totis invisibilibus obsoletis; petioli graciles, 1–2 cm. longi, supra plani vel leviter canaliculati. Inflorescentia fructifera satis gracilis, 9–10 cm. longa, rhachi minute tomentella, cupulis 3–4-ni glomeratis plus minusve confluentibus cupuliformibus circiter 5 mm. altis et 8 mm. latis vel interdum minoribus, bracteis dense imbricatis triangulari-ovatis obtusis vel obtusiusculis leviter vel vix turgidis fusco-tomentellis, glande ovoideo-conica, 7–8 alta et lata, basi circiter terta parte inclusa, fusco-brunnea, nitidula.

CHINA. Szechuan: Loshan hsien, Kiating, alt. 450 m., in thickets, *W. P. Fang*, no. 2290, July 28, 1928 (tree 20 m. high).

This new species is chiefly characterized by the rather small elliptic or elliptic-ovate glabrous leaves with flat midrib above and without reticulation beneath and by the slender fruiting spike, the small brown tomentulose hemispheric cups embracing about ⅓ of the conic-ovoid brown nut. It seems most closely related to *Lithocarpus viridis* (Schottky) Rehd. & Wils., *L. glabra* (Thbg.) Nakai, *L. spicata* (Sm.) Rehd. & Wils. and *L. Henryi* (Seemen) Rehder & Wils. which all differ in their larger and longer leaves with distinctly elevated midrib, larger acorns on a stouter rachis usually only at the base embraced by the nearly patelliform cupula with gray pubescent scales, the leaves except of *L. viridis* being distinctly though slightly reticulate beneath.

Ulmus glaucescens Franchet in Nouv. Arch. Mus. Paris, sér. 2, VII. 76, t. 8, fig. A (Pl. David. I. 267) (1884).—Schneider in Sargent, Pl. Wilson. III. 263 (1916).— Rehder in Jour. Arnold Arb. IV. 168 (1923).

INNER MONGOLIA: "Toumet, Sartchy," *A. David*, no. 2634 (ex Franchet); Wu ye hsien, alt. 1200–1400 m., *R. C. Ching*, no. 15, April 2–13, 1923.

CHINA. Chili: Kalgan, hill slope, *J. C. Liu*, nos. 584 and 585, May 28, 1927. Kansu: Ho lan shan mountains, alt. 1375–2400 m., *R. C.*

Ching, nos. 88, 140, May 10–25, 1923 (National Geog. Soc. Cent. China Exp.) (small tree up to 6 m. high).

This species which has been known so far only from David's collection near Sartchy or Sarchi about 20 miles west of the border of Northern Shansi has now turned up east and west of this locality, namely in northern Chili, at another locality in Mongolia west of Sarchi and in Kansu. It is very similar to *Ulmus pumila* L. and like this it has small glabrous leaves with simple or nearly simple teeth, but the leaves are dull, somewhat bluish green above, comparatively shorter and broader, with fewer, usually 7–9 pairs of veins, while *U. pumila* often has more than 10 pairs of veins. The chief difference is in the fruit, which is broadly elliptic or elliptic-obovate, more or less narrowed at base and 2–2.5 cm. long, while in *U. pumila* the samaras are suborbicular, rounded at base and not more than 15 mm. long.

Ulmus glaucescens var. **lasiocarpa**, var. nov.

A typo recedit samaris tota facie, in centro densius marginem versus sparsius pilosis, orbiculari-ellipticis 2–2.3 cm. longis et 1.8–2 cm. latis, basi fere rotundatis.

China. Kansu: Ho lan shan Mountains, alt. 1375–2400 m., *R. C. Ching*, no. 160, May 10–25, 1923 (small tree).

This interesting variety which differs from the type in its pilose samaras resembles in this character *U. Davidiana* Planch. and *U. macrocarpa* Hance, which however, differ in their much larger doubly serrate and generally obovate leaves pubescent in *U. Davidiana*, scabrid in *U. macrocarpa*. No other species of *Ulmus* is known which varies with pubescent and glabrous fruit, but as this plant agrees in every other character perfectly with typical *U. glaucescens* and grows with it at the same locality, it can hardly be considered anything else but a variety or form of that species.

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Litsea piperita Jussieu in Ann. Mus. Paris, VI. 213 (1805).
Persea cubeba Sprengel, Syst. II. 269 (1825).
Litsea citrata Blume, Bijdr. 595 (1825).—Gamble in Jour. As. Soc. Beng. xxv. pt. I. 146 (1912).—Lecomte, Fl. Indochine, v. 138 (1914).
Tetranthera polyantha Wallich, Cat. no. 2538 (1830), nom. nudum.—Nees in Wallich, Pl. As. Rar. II. 67 (1831); Syst. Laur. 545 (1836).
Tetranthera citrata Nees, Syst. Laur. 560 (1836).
Daphnidium cubeba Nees, Syst. Laur. 615 (1836).
Tetranthera floribunda Champion in Hooker Kew Jour. Bot. v. 199 (1853).
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Litsea mollis Hemsl. var. *glabrata* Diels in Bot. Jahrb. xxix. 349 (1900), synon. nov.
Lindera Dielsii Léveillé in Fedde, Rep. Spec. Nov. x. 370 (1912).
Actinodaphne citrata Hayata, Icon. Pl. Formos. III. 164, fig. 21 (1913).—Kanehira, Formos. Trees, 413, fig. (1917).

Litsaea Dielsii Léveillé, Fl. Kouy Tchéou, 220 (1914), nomen.
Litsea citrata var. *citrata* Hochreutiner in Candollea II. 362 (1925).
Litsea citrata var. *polyantha* Hochreutiner, l. c.
Litsea Hui Diels in herb., synon. nov.

I have followed Merrill in referring this very widely distributed species generally known as *Litsea citrata* Bl. to *Litsea cubeba* Pers. which is based on *Laurus cubeba* Lour. Of *Litsea mollis* var. *glabrata* Diels I have before me a duplicate of Bock and Rosthorn's no. 153, a co-type of the variety, and of *Litsea Hui* I have a specimen of Hu's no. 903, the holotype of this species. Both undoubtedly belong to *L. cubeba* (Lour.) Pers., the first specimens bearing young inflorescences and old frutescences with the fruits dropped and the second is a fruiting branch.

Benzoin touyunense (Lévl.) Rehder in Jour. Arnold Arb. x. 194 (1929).
Litsea touyunensis Léveillé in Fedde, Rep. Spec. Nov. XI. 63 (1912); Fl. Kouy-Tchéou, 220 (1914), as *Litsea touyounensis*.

CHINA. Kweichou: Tou-yun, *J. Cavalerie*, no. 1, Nov. 10, 1902 (type). Hupeh: Changyang hsien, *E. H. Wilson*, no. 302, in part, Nov. 1907; Ichang, *E. H. Wilson*, no. 302, in part, March 20, 1909. Kwangtung: way to Sie-kun, Lokchong hsien, North River Region, *Tsiang Ying*, no. 1436, Oct. 23, 1928 (tree 40 ft. high, with lenticellate bark and brittle branches).

FORMOSA: Karenko to So-o, prov. Karenko, *E. H. Wilson*, no. 11087, Nov. 24, 1918.

When I first identified *Benzoin grandifolium* Rehd. with *Litsea touyunensis* I pointed out the difference in the pubescence of the two specifically identical forms, but did not distinguish the glabrous plant by a distinct name. Now, however, as a well marked strongly pubescent form has come to light, it seems advisable to distinguish and name the two extremes of this species.

The type of *B. touyunense* has the under side of the leaves fairly densely villous-pubescent with the midrib glabrescent, the upper surface is perfectly glabrous, as are the branchlets and petioles, the two outer bracts of the inflorescence are glabrate and the peduncles minutely pubescent. The specimens from Hupeh and from Formosa are somewhat less densely pubescent on the under side of the leaves, while the Kwangtung specimen shows a slight and minute pubescence also on the petioles of the leaves, besides it has broader leaves up to 7 cm. wide and to 16 cm. long and larger fruits fully 2 cm. long.

Benzoin touyunense f. megaphyllum (Hemsl.), f. nov.
Lindera megaphylla Hemsley in Jour. Linn. Soc. XXVI. 389 (1891).—Gamble in Sargent, Pl. Wilson. II. 80 (1914).—Non *Benzoin megaphyllum* Ktze.
Benzoin grandifolium Rehder in Jour. Arnold Arb. I. 145 (1919).
Benzoin touyounense (Lévl.) Rehder in Jour. Arnold Arb. x. 194 (1929), in part.

A typo recedit foliis glaberrimis.

CHINA. Kiangsi: Kiukiang Mts., *E. Faber* (ex Henry). Hupeh: Ichang, *A. Henry*, nos. 1112, 1284, 2195, 3010, 3010a; Patung, *A. Henry*, nos. 3151, 3345, 3345a and 3345b; Chienshi, *A. Henry*, no. 4508; Nanto

and mts. to the northward, *A. Henry*, nos. 6609, 7525, 7618, 7848a. Ichang, alt. 300–900 m., *E. H. Wilson*, Veitch Exped. no. 59, April and Oct. 1900; same locality, *E. H. Wilson*, Arnold Arb. Exped. no. 302, in part, March 15 and Oct. 1907; Chang-lo hsien, alt. 300–900 m., *E. H. Wilson*, no. 302, in part, April and May 1907; Chanyang hsien, alt. 600 m., *E. H. Wilson*, no. 302, in part, July 1907; Hsing shan hsien, alt. 750 m., *E. H. Wilson*, no. 302, in part, October 1907; "Ou-pan-chan," alt. 600 m., *C. Silvestri*, no. 2985, March 23, 1910; Da yu tze, alt. 750 m., *W. Y. Chun*, no. 3567, July 27, 1922; Siu yeh see, *W. Y. Chun*, no. 4391, Oct. 30, 1922. Hunan: in silva infra vicum Tungdjiapi prope minas Hsikwangschan distr. Hsin wha, alt. 550 m., *Handel-Mazzetti*, no. 11888, May 20, 1918. Anhwei: Chemen, alt. 225 m., *R. C. Ching*, no. 3129, Aug. 5, 1925. Szechuan: distr. "Tchen-kéou-tin," *P. Farges*, no. 1211; Mt. Omei, alt. 300–1200 m., *E. H. Wilson*, no. 3706, in part, June 1908; Wênchuan hsien, Min Valley, alt. 600–1200 m., *E. H. Wilson*, no. 3706, in part, Oct. 1908. Yunnan: Yuan-chiang, alt. 1500–1800 m., *A. Henry*, nos. 13275 & 13275a.

Formosa. Taihoku, prov. Sekitei, *E. H. Wilson*, no. 10168, March 17, 1918.

As the above enumeration of the specimens shows the glabrous form is by far the most common and most widely distributed, its range extending from Formosa and Kwangtung to northwestern Szechuan and southern Yunnan, while the type, though of similar range, but apparently much less common, has not yet been collected in Kwangtung, Hunan, Szechuan and Yunnan, and the following form is known only from Szechuan.

Benzoin touyunense f. **trichocladum**, f. nova.

A typo recedit ramulis, petiolis et costa folii subtus tomentoso-villosis, costa supra breviter minute villosa, facie inferiore praecipue ad nervos et venulos villosis.

China. Szechuan: Nanchuan hsien, *W. P. Fang*, no. 5843, Nov. 9, 1928.

This form on account of the dense grayish yellow pubescence of the branchlets, petioles and the under side of the midrib looks at the first glance very distinct from typical *B. touyunense* and its glabrous form and one might be inclined to rate it higher than a mere form, if not Ying's no. 1436 from Kwangtung enumerated under typical *B. touyunense* showed a slight pubescence on the young branchlets and on the petioles and thus forms a transition to the form described above.

Philadelphus paniculata, sp. nov.

Frutex 3-metralis, ramulis maturi rubro-fusci, annotini cortice lamellis tenuibus solubili. Folia elliptico-ovato vel oblongo-ovata, 6–11 cm. longa et 2.5–6 cm. lata, acuminata, basi late cuneata, integra vel minute et distanter denticulati denticulis ad glandulam reductis (in ramulis floriferis

qui tantum adsunt), supra intense viridia, pilis adpressis laxis conspersa, subtus pallide viridia, ad nervos et venulas primarias sparse strigoso-pilosa, ceterum glabra, nervorum paria basalia satis distantia plerumque 2, in axillis non barbata; petioli glabri, circiter 5 mm. longi. Ramuli floriferi glabri, plerique foliorum paribus tribus, paribus duobus superioribus flores in axillis gerentibus; inflorescentia fructifera paniculata capsulas 20 vel plura gerens, 12–16 cm. longa; axes glabri; axium lateralium paria 3 inferiora 2–4-, pleraque 3-flora, 3 vel 4 superiora uniflora; pedunculi circiter 1 cm. longi; pedicelli 6–10 mm. longi, sparse pilosi; calycis tubus et sepala extus adpresse pilosa; sepala ovata, acuminulata, cira 4 mm. longa, intus tomentosula; stylus basi pilosus, circa 6 mm. longus, apice tantum divisus, stigmatibus ut videtur satis latis; capsula non perfecte matura circa 1 cm. longa.

CHINA. S z e c h u a n : Kuan hsien, alt. 900–1050 m., in thickets, *W. P. Fang*, no. 2237, July 15, 1928.

This new species differs from all other Chinese species in its paniculate inflorescence, a character found so far only in a few Californian species; it seems nearest related to *Philadelphus sericanthus* Koehne which is easily distinguished by the simple 7–11-flowered raceme and the distinctly dentate leaves nearly glabrous beneath even on the veins and bearded in the axils. It is also related to *P. subcanus* Koehne, but that species has 5–9-flowered simple racemes and the leaves more or less pubescent beneath. In *P. paniculatus* the 3 or 4 upper lateral axes of the inflorescence are one-flowered, while the 3 or rarely 4 lower axes bear a cyme of usually 3 flowers sometimes augmented by a fourth flower springing from one of the lateral pedicels, or occasionally an additional flower on a solitary pedicel appears below the peduncle in a vertical plane, while the normal cyme branches in a horizontal plane. I have never observed these accessory basal pedicels oriented in a vertical plane in *P. californica* Benth.

Hydrangea strigosa Rehd. f. **sterilis**, f. nov.

Hydrangea aspera ε. *sinica fl. sterilibus* Diels in Bot. Jahrb. XXIX. 375 (1900).

A typo recedit floribus omnibus sterilibus inflorescentiam plus minusve hemisphaericam formantibus.

CHINA. S z e c h u a n : Nanchuan, Ma fu lin po, *A. v. Rosthorn*, no. 629, Aug. 1891 (shrub 2 m.; type); Mt. Omei, *E. H. Wilson*, Veitch Exped. no. 4902a, Sept. 1904; same locality, alt. 450–600 m., in thickets, *W. P. Fang*, no. 2313, Aug. 1, 1928, (shrub 2 m.). H u p e h : Fang hsien, alt. 1200–1800 m., thickets, *E. H. Wilson*, no. 2390, Aug. 1907 (shrub 1–1.5 m., flower pink).

In the four specimens enumerated above all the flowers have assumed the shape of the sterile marginal flowers with enlarged sepals, but the specimens differ more or less in the shape of the leaves and the size of the sepals. The specimen from Nanchuan is according to the shape of the leaves referable to var. *sinica* (Diels) Rehd., and Fang's no. 2313 from

Mt. Omei to var. *angustifolia* (Hemsl.) Rehd., while Wilson's no. 4902 from Mt. Omei and no. 2390 from Hupeh are intermediate between var. *angustifolia* and var. *macrophylla* (Hemsl.) Rehd. They also differ in the size of the flowers which are only 12–15 mm. across in Fang's no. 2313, about 2 cm. in Rosthorn's no. 629, and about 3 cm. in Wilson's nos. 4902a and 2390, and in the margin of the sepals which is entire in Fang's specimen and in Wilson's no. 2390, somewhat toothed in Wilson's no. 4902a and very sparingly so in Rosthorn's specimen.

All the specimens seem to have been collected from plants growing wild and not as one might assume from cultivated plants. We also know that the sterile forms of the American *H. arborescens* L. and *H. cinerea* Small now much cultivated have been found originally wild in the woods, while the sterile forms of *H. macrophylla* (Thbg.) DC. and of *H. paniculata* Sieb. have been introduced from the gardens of the Far East into western gardens.

Hydrangea villosa Rehd. f. **sterilis**, f. nov.

A typo recedit floribus omnibus sterilibus inflorescentiam hemisphaericam formantibus.

China. Hupeh: Mts. near Ichang, *E. H. Wilson*, Veitch Exp. no. 1473a, August, 1900 (bush 2–3.5 m.; flowers pinkish).

This is another form with all the flowers sterile of which now quite a number are known belonging including this form, to four Asiatic and to two American species. Like the preceding form it has been apparently collected in a wild state. According to the character of its pubescence it does not belong to typical *H. villosa* but to its var. *strigosior* (Diels) Rehd.

Cotoneaster rotundifolia Wall. var. **tongolensis**, comb. nov.

Cotoneaster disticha var. *tongolensis* Schneider, Ill. Handl. Laubholzk. 1. 745, fig. 419d (1906).—Rehder & Wilson in Sargent, Pl. Wilson. 1. 154 (1912).

China. Szechuan: Tongolo, *J. E. Soulié* (ex Schneider); uplands around Tachienlu, alt. 2600–3000 m., June 1908, *E. H. Wilson*, no. 2186, June 1908 (decumbent bush, 1 m. tall); Baurong to Tachienlu, via Hadjaha, alt. 2750–4650 m., *Herbert Stevens*, no. 338, May–June, 1929.

This variety differs from typical *C. rotundifolia* in the usually more acute or acutish broad-oval or oval leaves pubescent beneath, in the usually slightly pubescent, rarely nearly glabrous calyx-tube, in the flowers being borne often in twos or threes at the end of the branchlets. It may possibly be a distinct species.

Rosa Soulieana Crép. var. **sungpanensis**, var. nov.

A typo recedit foliolis multo majoribus ad 3.5 cm. longis et 2.2 cm. latis, obovatis vel elliptico-obovatis apice saepius fere rotundatis et acuminulatis, crenato-serrulatis vel serrulatis, corymbis multifloris 10–15 cm. diam. sepalis ovato-lanceolatis 12–15 mm. longis, columna stylari in stylos distinctos dissoluta, disco in annulum 1.5 mm. altum producto stylos basi cingente.

CHINA. S z e c h u a n : Sungpan hsien, on side of river, *W. P. Fang*, no. 1525, Aug. 2, 1928 (shrub 2–3 m.; flowers whitish.)

This variety looks at the first glance very different from *Rosa Soulieana*, but agrees in all essential characters with that species except that the leaflets are much larger and the flowers are borne in broad many-flowered corymbs at the end of long vigorous shoots. Dissolved stylar columns are also found occasionally in specimens of otherwise typical *R. Soulieana* as in Wilson's no. 4164 collected between Maochou and Sungpan which also has leaves similar in shape but only 1–1.5 cm. long; the inflorescence is usually only 3-flowered and the disk only little produced above the mouth.

Rosa Stevensii, spec. nov.

Frutex robustus ut videtur; rami robusti ut ramuli glabri, aculeis sparsis rectis 5–10 mm. longis basi dilatatis partim infrastipularibus muniti. Folia pleraque 9-, interdum 11-foliolata, cum petiolo 1.5–3.5 cm. longo 11–13 cm. longa; foliola breviter, terminale longius petiolulata, elliptica, 2–3 cm. longa et 1–2 cm. lata, basi late cuneata, apice acutiuscula vel obtusiuscula et mucronulata, argute simpliciter serrata, supra glabra, subtus pallide viridia ad costam mediam satis dense et molliter, ad nervos laterales sparsius pubescentia, ceterum glabra vel fere glabra, nervis utrinsecus circa 8–10 leviter elevatis, reticulo venularum denso impresso; stipulae conspicuae, 2–2.5 cm. longae et 5–8 mm. latae, auriculis late ovatis, dense stipitato-glanduloso-ciliatae, subtus praesertim ad nervos et venulas glandulosae, ceterum glabrae; petioli et rhachis laxe pubescentia et satis dense stipitato-glandulosa. Inflorescentiae pleraequae 3-florae, basi pauci-bracteatae; flores circa 4.5 cm. lata, purpurea; pedicelli graciles, 2–3 cm. longi, ut hypanthium infra medium aculeolato-setosi setis glanduligeris; hypanthium oblongum apice attenuatum; sepala ovata in acumen longum foliaceum attenuata, integra, petalis plerumque paullo longiora, extus glandulis stipitatis praesertim ad margines exteriores ornata, marginibus interioribus tomentellis exceptis extus glabra intus dense tomentella; petala suborbicularia, extus tomentella; stamina numerosa, filamentis ut videtur purpurascentibus et antheris fuscescentibus (in sicco) 2 mm. longis; capitulum stigmaticum subsessile.

CHINA. S z e c h u a n : Baurong to Tachienlu, via Hadjaha, alt. 2750–4650 m., *Herbert Stevens*, no. 215, May–June 1929 (Kelley-Roosevelt Exped.).

This handsome Rose seems to be most closely related to *R. caudata* Bak., but is easily distinguished by the pubescent leaves, the very large stipules and the petals being tomentulous outside; from *R. Sweginzowii* Koehne and *R. Moyesii* Hemsl. & Wils., to which it seems also related, it differs in the entire sepals, the slender pedicels and the tomentulous petals. The latter character is rather unusual in the genus.

Prunus phaeosticta Maxim. f. **dentigera**, forma nov.

A typo recedit foliis supra medium remote spinuloso-denticulatis denticulis utrinque 2–6 minus longe caudatis, leviter bullatis, nervis subtus magis elevatis.

China. Szechuan: Kikiang hsien, alt. 1050–1375 m., in thickets, *W. P. Fang*, no. 1314, June 11, 1928 (tree 10 m.).

This form looks at the first glance on account of its toothed somewhat bullate leaves rather distinct from the type which has quite entire flat leaves, and is found in southeastern China and in Japan. In western China *P. phaeosticta* seem to be represented only by this and the following form.

Prunus phaeosticta Maxim. f. **lasioclada**, forma nov.

A typo recedit ramulis fulvo-villosulis foliis integris vel partim sparse et minutissime denticulatis.

China. Yunnan: Szemao forest, alt. 1500, *A. Henry*, no. 11666 (tree 6 m.; flowers white) (type); without precise locality, *G. Forrest*, nos. 15750, 15802, 17489, 17710, 17721, 17760, 17888, 18112.

Upper Burma: hills around Stawgaw, Lat. 26° N., Long. 98° 25′ E., in mixed thickets, *G. Forrest*, no. 26500, in 1924–1925 (shrub 30 ft.; flowers white).

This form differs from the type in its short-villous young branchlets and in the leaves being on the same branch either entire or toward the apex minutely and remotely denticulate; in Henry's specimen and in every one of the Forrest numbers from Yunnan minute teeth can be found at least on a few leaves of every specimen which seems to show that the presence of teeth is a character of the western forms of *P. phaeosticta*, for in every one of the many specimens before me from southeastern China and from Formosa the leaves are quite entire and the branchlets lack the villous pubescence. Forrest's specimen from Burma, however, agrees in its entire leaves with the type and the pubescence of the branchlets is not quite as conspicuous as in the Yunnan specimens.

Ilex latifolia Thbg. var. **Fangii**, var. nov.

A typo recedit folius angustioribus oblongis vel oblongo-lanceolatis vel oblongo-oblanceolatis 9–13 cm. longis et 2.8–4.8 cm. latis utrinque attenuatis apice magis acuminatis minus crasse coriaceis, ramis et ramulis fuscis gracilioribus.

China. Szechuan: Mt. Omei, alt. 1375–1675 m., in thickets. *W. P. Fang*, nos. 3098 and 3144, Aug. 17 and 18, 1928 (shrub 5 m.).

The two specimens cited above which are in young fruit seem to agree in all essential characters with typical *I. latifolia* except that the leaves are smaller and narrower, longer-acuminate and somewhat less thickly coriaceous; also the branchlets are less stout measuring toward the apex only about 2 mm. in diameter. To my knowledge the species has not been found west of Chekiang and Kiangsu, and the Omei plant may therefore be considered a geographical variety and not a mere narrow-leaved form.

Evonymus centidens Léveillé in Fedde, Rep. Spec. Nov. XIII. 262 (1914); Cat. Pl. Yun-Nan, 34, fig. (1915).

Frutex 2-metralis glaber, sempervirens, ramulis glabris gracilibus acute quadrangulatis, annotinis plus minusve verruculosis demum fuscis subteretibus; gemmae terminales parvae, perulis paucis lanceolatis glabris interdum sparsisime fimbriato-lobulatis. Folia opposita, chartacea, brevissime petiolata petiolo canaliculato circa 2 mm. longo, oblonga vel oblongo-lanceolata vel oblongo-oblanceolata, 3–8 cm. longa et 1.1–2.5 cm. lata, argute et dense serrulata dentibus erecto-patentibus glandula parva fusca terminatis, luteo-viridia, subtus pallidiora, costa media supra et subtus elevata, nervis utrinsecus 5–7 supra fere obsoletis subtus prominulis nervis secundariis leviter prominulis conjunctis, venulis obsoletis. Inflorescentiae in parte aphylla inferiore ramulorum hornotinorum vel in apice ramulorum brevium vel e gemmis perulatis axillaribus ramulorum annotinorum, pleraeque triflorae vel 1–2-florae, pedunculo gracili 2–7 mm. longo, pedicellis 2–4 mm. longis; flores 4-meri, circa 7 mm. diam., sepalis semi-orbicularibus, petalis suborbicularibus 2–5 mm. longis et 3 mm. latis leviter vel vix crenulatis, filamentis brevissimis, antheris subglobosis luteis, ovario breviter conico; capsulae solitariae (semper?) lobis fere ad basin partitis ellipsoideis 6–7 mm. longis obtusis, plerumque tantum uno vel duobus rarius tribus evolutis, monospermis; arillus scarlatinus, apertus, semen fere nigrum dimidium tantum vel paullo ultra tegens.

CHINA. Yunnan: "collines broussailleuses à Long-ky," alt. 700 m., *E. E. Maire*, June 1912 ("grand arbuste à feuilles caduques") (type). Szechuan: Nanchuan hsien, in thickets, *W. P. Fang*, no. 5819, Nov. 8, 1928 (shrub 2 m.).

Though the type of *E. centidens* is based on a flowering specimen and Fang's plant from Szechuan is in fruit, I have no doubt that the two specimens are identical, since they agree well in their vegetative characters and in the inflorescence except that the leaves in Maire's specimen are generally larger attaining up to 8 cm. in length, and 2.8 cm. in width, while those of Fang's specimen are not larger than 6 × 2 cm. The leaves are not membranous as described by Léveillé, but distinctly chartaceous or subcoriaceous and at least partly persistent. The species seems to be most closely related to *E. Dielsiana* Loes. from which it differs chiefly in the closely and sharply serrulate leaves, the shorter petioles and the shorter peduncles. It also agrees with *E. Dielsiana* Loes. in its fruit which is very similar to that of *E. alata* (Thbg.) Reg. and of *E. Euscaphis* Hand.-Mazz.; in all these species the fruit is deeply lobed nearly to the base and of the four carpels usually only 1–3 develop, so that the mature fruit is usually 1–3- instead of 4-lobed.

As Léveillé's description is very meagre and based only on flowering material I have given above a full description of the species, based on Maire's flowering and Fang's fruiting specimens.

Microtropis fokienensis Dunn in Jour. Linn, Soc. XXXVIII. 357 (1908).—Dunn & Tutcher, Fl. Kwangtung (Kew Bull. Add. Ser. x. 61 [1912]).

CHINA. Fukien: Yenping, alt. 1500 m. *S. T. Dunn*, April to Nov. 1905, (Hongkong Herb. 2394; isotype). Kwangtung: Swatow district (ex Dunn & Tutcher). Chekiang: Tientai shan, Huating, *C. Y. Chiao*, July 23, 1927 (Herb. of Univ. Nanking no. 14480). Szechuan: Nanchuan hsien, in thickets, *W. P. Fang*, no. 5756, Nov. 5, 1926 (shrub 4 m.).

This species had been known before only from southeastern China, where it has been collected in Fukien, Kwangtung and Chekiang. The Szechuan plant differs only slightly from the type in the longer peduncles and pedicels, the former being 5–7 mm. long and the pedicels of the lateral flowers of the 3-flowered cyme being up to 3 mm. long, while the terminal one is subsessile; also the leaves are longer and narrower being up to 7 cm. long and 1.6–2 cm. wide, while in the type they are up to 6 cm. long and 2–2.8 cm. wide. The Chekiang specimens resembles the Szechuan plant in its leaves, but has the short peduncles and pedicels of the type.

Eurya Fangii, sp. nov.

Frutex metralis, ramis suberectis ramulis hornotinis satis dense strigoso-pilosis vel setoso-pilosis tertio anno glabrescentibus. Folia persistentia, subcoriacea, brevissime petiolata petiolo 1–2 mm. longo glabro, elliptica vel oblongo-elliptica, 2.5–3.5 cm. longa et 10–14 mm. lata, basi cuneata, apice breviter obtuse acuminata, minute serrulata dentibus mucrone acuto incurvo terminatis, supra atroviridia, subtus flavo-viridia, glabra, costa supra incisa subtus elevata, nervis utrinque 6–8 supra leviter impressis subtus prominulis, venulis supra obsoletis vel levissime impressis subtus leviter elevatis. Flores (alabastra tantum visa) in axillis foliorum solitarii; pedicelli glabri, 1–2 mm. longi; bracteae 2, suborbicularia, 0.5–1 mm. longae, majore minute ciliolata; sepala late ovata, 2 mm. longa, obtusa, minute ciliolata. Baccae subglobosae, circiter 5 mm. longae; semina numerosa, suborbicularia, circa 1.25 mm. diam., leviter compressa, rubro-brunnea.

CHINA. Szechuan: Omei hsien, Mt. Omei, in thickets, alt. 2600–2750 m., *W. P. Fang*, no. 2917, Aug. 13, 1928 (shrub 1 m.).

This new species seems to be most closely related to *E. japonica*, but differs chiefly in the hirsute branchlets, the smaller leaves with impressed veins above and the ciliolate sepals.

Stachyurus yunnanensis Fr. var. **obovata**, var. nov.

A typo recedit foliis tenuioribus, obovatis, infra medium basin versus sensim in petiolum attenuatis apice subito in acumen 1–1.5 cm. longum productis, 5.5–7.5 cm. longis et supra medium 2–3 cm. latis.

CHINA. Szechuan: Kuan hsien, alt. 1075 m., in woods, *W. P. Fang*, no. 2000, July 4, 1928 (tree 4 m.).

This plant looks at the first glance very distinct on account of its

obovate almost lyrate caudate-acuminate leaves, but the leaves of some specimens of *S. yunnanensis* before me show a tendency toward an obovate shape and the serration agrees with that of *S. yunnanensis*. As the flowers are unknown, the specimen bearing young fruits, it does not seem wise to describe it as a new species.

Schefflera Bodinieri, comb. nov.

Heptapleurum Bodinieri Léveillé in Bull. Acad. Intern. Geog. Bot. XXIV. 144 (1914); Fl. Kouy-Tchéou, 35 (1914).

Frutex; ramuli initio farinaceo-puberuli mox glabrescentes, annotini pallide rubro-brunnei. Folia longe petiolata petiolo gracili terete 8–15 cm. longo glabro, digitata; foliola membranacea, plerumque 7–9, interdum 5–6, inaequaliter petiolulata petiolulis glabris infimis brevissimis 1–2 mm. longis, terminali 1.5–5 cm. longo, ceteris intermediis, inferiora ovata-lanceolata vel lanceolata, 4–7 cm. longa et 1–1.6 cm. lata, terminale lineari-lanceolata, 10–16 cm. longum, 1–2.5 cm. latum, cetera intermedia, basi late cuneata vel interdum fere rotundata, sensim longe acuminata, remote sparseque denticulata denticulis utrinque 1–8, rarius integra, supra atroviridia, subtus glauca et initio sparsissime farinaceo-puberula, mox fere glabra, costa media supra prominula, subtus elevata, nervis utrinsecus 8–16 fere obsoletis. Inflorescentia pedunculo circa 1 cm. longo incluso 7–11 cm. longa, umbellulis 6–7 multifloris globosis circiter 2 m. diam., racemosa vel axi laterali inferiore iterum racemoso paniculata, farinaceo-puberula; pedunculi umbellularum 1–2 cm. longi, bi-bracteolati bracteolis parvis plerumque infra medium pedunculi insertis et saepe gemmam abortivam in axilla gerentibus; pedicelli 2–5 mm. longi, graciles, farinacei; calycis margo 5-denticulatus denticulis discum superantibus; petala 5, oblongo-ovata, 3–3.5 mm. longa, acutiuscula, reflexa, extus sparse farinacea; stamina 5, petalis paullo longiora; discus annularis crassus; stylus 1–2 mm. longus, striatus, stigmate punctiformi indiviso coronatus; ovarium 5-loculare, extus farinaceo-puberulum. Fructus non visi.

CHINA. Kweichou: "district de Tsin-gay, vallée de Kia-la-tchong," *J. Laborde* in herb. Bodinier, no. 2459, Dec. 21, 1897 ("grand arbuste") (syntype); "environs de Kouy-yang, mont du Collège," *E. Bodinier*, Sept. 1898 (flowers), Feb. 17, 1898 (fruit) (ex Léveillé) (syntype); "route de Pin-fa à Kouy-tin," *J. Cavalerie*, nos. 747, 3098 (syntype), Oct. 1 and Dec. 4, 1902 (ex Léveillé); Long-ly, *J. Cavalerie*, no. 1567, Sept. 1897. Szechuan: Nanchuan hsien, woods, *W. P. Fang*, no. 5740, Nov. 4, 1920 (shrub 1–2 m.).

This species is apparently related to *Schefflera octophylla* (Hance) Harms and *S. hypoleucoides* Harms but is easily distinguished by the smaller and narrowly linear-lanceolate remotely serrulate membranous leaflets and the much smaller inflorescence. It also resembles *Brassaiopsis speciosa* Dcne. & Pl. from which it differs in the same characters and in the 5-celled ovary. As Léveillé's description is very brief and incomplete, I have given above a detailed description based on Laborde's no.

2459 which may be considered the type, on Cavalerie's no. 1567 and Fang's no. 5740.

Vaccinium conchophyllum, sp. nov.

Frutex sempervirens, ut videtur semiprostratus, 20–30 cm. altus, ramis crassiusculis; ramuli angulati, breviter patenti-pilosi, brunnescentes, vetustiores glabrescentes, grisei. Folia crasse coriacea, satis congesta apicem versus fere imbricata, brevissime petiolata petiolo 1–2 mm. longo glabro, late ovalia vel late obovato-ovalia, 8–14 mm. longa et 6–9 mm. lata, apice rotundata basi late cuneata vel rotundata, margine initio ciliato hyalino integro recurvo, ideo folia subtus plus minusve concava, supra initio laxe villosa mox costa media villosula excepta glabrescentia, reticulato-rugosa, subtus laevia, pallide viridia, ab initio glabra, costa media supra impressa sed basin versus prominula subtus levissime vel vix elevata, nervis utrinque 3–4 supra impressis subtus obsoletis. Flores rubri, in racemis 4–6-floris axillaribus solitariis vel paucis in apice ramulorum brevibus; rhachis glabra; bracteae oblongae, glabrae, pedicellis 1–2 mm. longis glabris longiores, caducae; sepala triangulari-ovata, 1.5 mm. longa, acuta, ovario paullo breviora, glabra; corolla ovoideo-urceolata, 5 mm. longo, lobis triangularibus brevissimis reflexis; stamina 10, filamentis latis pilosis 2 mm. longis, antheris 2-tubulosis glabris, in dorso ad apicem filamenti 2-aristatis aristis dimidios tubulos aequantibus; stylus glaber, staminibus subaequilongus. Fructus deest.

China. Szechuan: Nanchuan, alt. 2450–2750 m., in thickets, *W. P. Fang*, no. 849, (type) May 20, 1928 (bush 1 foot; flowers red).

This new species is apparently most closely related to *Vaccinium Nummularia* Hook. f. & Thoms. from Sikkim which is easily distinguished by the dense hispid pubescence of the branchlets, the hairs partly exceeding the diameter of the branchlets, by the pubescent rhachis of the usually larger inflorescence, and by the serrulate broadly ovate rather than broadly oval-obovate leaves with rounded or even slightly subcordate base; Hooker describes the leaves as subentire, but on Griffith's and his own specimens and on Schlagintweit's no. 14755 they are distinctly though minutely serrulate with mucronulate teeth.

Styrax Huanus, spec. nov.

Arbor 6–15-metralis; ramuli juniores pilis stellatis vestiti; annotini glabri, fusco-brunnei, cortice in lamellas tenues soluta. Folia alterna vel inferiora subopposita, petiolata petiolo 4–10 mm. longo stellato-piloso, elliptica vel elliptico-oblonga, interdum obovato-elliptica, 7–11 cm. longa et 3–5.5 cm. lata, basi cuneata, acuminata, minute denticulata supra obscure viridia, costa nervisque stellato-tomentosulis exceptis glabra vel fere glabra, interdum leviter rugulosa, subtus dense albido-stellato-tomentosa, utrinque nervis 6–8 angulo acuto divergentibus supra leviter vel vix impressis subtus elevatis ante marginem anastomosantibus. Inflorescentia fulvido-tomentosa, racemosa, terminalis, plerumque basi

1 vel 2 racemis ex axillis foliorum ortis aucta; racemi 7–12 cm. longi, 8–16-flori vel laterales minores; rhachis stellato-tomentosula; bracteae subulatae, pedicello breviores vel paullo longiores, rarius infima foliacea; pedicelli circa 5 mm. longi; calyx campanulatus, circa 5 mm. longus, extus dense fulvido-tomentosus, intus minute stellato-pubescens, basin versus glaber lobis late triangularibus 1–2 mm. altis acuminulatis; corolla 5-partita, tubo circa 5 mm. longo, lobis aestivatione imbricatis, elliptico-oblongis vel spathulato-oblongis, 12–14 mm. longis, 5–6 mm. latis, acutiusculis extus dense stellato-tomentosis intus sparsius pilis stellatis obtectis; stamina 10, tubo medio adnato, lobis paullo breviora, parte libera plana glabra circiter 8 mm. longa, antheris 4 mm. longis ad marginem sparsissime stellato-pilosis; stylus staminibus longior, lobos fere aequans, glaber; ovarium globoso-ovoideum, villosum semi-inferum, multi-ovulatum.

CHINA. S z e c h u a n : Nanchuan hsien, alt. 1200–2700 m., in thickets and woods, *W. P. Fang*, no. 1376, June 3, 1928 (type), no. 1133 and 1401, May 29 and June 4, 1928 (tree 6–15 m. high).

This new species seems closely related to *S. Hemsleyanus* Diels with which it agrees in general appearance, size and shape of the leaves, inflorescence and size of flowers, but from which it is easily distinguished by the dense white stellate tomentum of the under side of the leaves and also in the longer and glabrous filaments. It also resembles *S. rugosus* Kurz from Burma which differs chiefly in its more rugose leaves, much longer calyx-teeth, 6-parted corolla and superior ovary, and the North American *S. grandifolius* Ait. which has broader usually entire leaves, white-tomentose calyx nearly glabrous inside, and the filaments pubescent below.

I take pleasure in associating this handsome shrub with the name of Dr. H. H. Hu, Professor of Botany at the Fan Memorial Institute, Peiping.

Lonicera saccata Rehd. **f. calva,** forma nov.

A typo foliis utrinque glabris recedit.

CHINA. S z e c h u a n : Nanchuan hsien, alt. 2500–2750 m., in thickets, *W. P. Fang*, no. 845 (type), May 20, 1928 (shrub 4 m. tall; flowers white); summit of Nin tou shan, west of Kuan hsien, alt. 2750 m., *E. H. Wilson*, no. 1862 (in part), June 20, 1908.

Fang's no. 845 agrees in all its characters except in the lack of pubescence with the type. The corolla is distinctly saccate and the leaves are obovate-oblong with the veins yellowish beneath. Wilson's no. 1862, in this herbarium, consists of two branches, one with glabrous leaves and one with the leaves thinly pubescent beneath; the corollas on both branches are gibbous rather than saccate. The new form also approaches *L. aemulans* Rehd. which differs chiefly in its smaller obovate leaves, shorter pedicels and smaller flowers with gibbous, not saccate corolla.

THE PHYTOPHTHORA DISEASE OF THE CALLA IN AMERICA

KENNETH S. CHESTER

IN the early part of January of this year, my attention was called to a diseased condition of the cultivated Calla Lily, *Zantedeschia aethiopica* Spreng. (*Richardia aethiopica* Hort.), in a greenhouse in Martha's Vineyard, Mass. About one hundred plants were being reared for cut-flower purposes, and all showed to a pronounced degree the effects of a severe blight. The plants were stunted, none of the blossom stalks was over two feet in length, and some were less. Many of the leaves were completely dead, and others were dying from the margins inward. A few of the blossoms were of perfect appearance though small, but most of them showed a browning of the distal portion of the spathe, ruining the commercial value. The symptoms pointed to a root or nutritional derangement. On knocking out the earth ball, a few excellent young roots were seen, but the great majority were either partly or completely rotted with only the papery root-sheath remaining, or were entirely absent with the impression of the root left in the soil. Both new and dead roots came from the same region of the corm. The partly-affected roots showed a glassy, translucent, water-soaked appearance between the normal portion and that completely rotted. Associated with the glassy appearance of the roots was a slight red discoloration in spots. The corms themselves showed various degrees of rot. In some only the lower end of the corm was decayed, in others half or more than half was brown and mushy. In the worst cases the whole corm was completely rotted away within the outer shell, and the base of the stalk could be pushed into the mushy mass. Even in these last cases, however, the top was partly green, and a few good roots were attached to the base of the stalk.

The course of the disease is a slow wasting one. The plants do not die immediately, but continue in a state of reduced vitality to produce sickly, non-marketable blossoms.

Believing that this trouble might be due to unfavorable physical or chemical soil conditions, the propagator carried out a set of experiments in an attempt to ameliorate the blighted condition. Thirty pots, each of three plants, were treated with varying amounts of water, lime, liquid hen manure, soot, and bone meal, in addition to the usual "liquid feed." But no improvement resulted, for all, including the control plants, showed the effects of the disease to the same extent when examined several months later. It was at this stage that the diseased Callas came under my observation.

The general symptoms indicated that the disease was of a biotic rather than abiotic cause, and microscopic investigation at once revealed the presence of a fungus. The next step was the isolation and identification of the fungus. The glassy roots of several plants were washed and placed in a little water in moist chambers. *Phytophthora* sporangia developed

in abundance from cortical ruptures in the glassy region after 24 hours, and after 48 hours had proliferated and liberated zoospores in abundance. Four months later the same technique was repeated with the same plants and the same results obtained. Examination of the sporangia showed them to be the centrally proliferating type described by Buisman (2) for *Phytophthora Richardiae* Buis., a virulent parasite of the Calla in Europe. In appearance and size the sporangia and zoospores were in conformity with Buisman's description, while the symptoms corresponded precisely to those seen in Europe. It so happened that Dr. Buisman was working in the Arnold Arboretum at the time, and when shown the diseased plants and the cultures of the fungus she expressed no doubt that the disease is identical with the European disease caused by *Phytophthora Richardiae.*

The Calla disease was first observed by Buisman in Holland in the few years prior to 1927. It was noted for the first time in England in 1927 by Salmon and Ware (3) and found to be identical with the Dutch disease. Incidentally it may be mentioned that Ashby (1), after a study of the fungus that causes the disease in Europe, has expressed the opinion that it is a variety of *Phytophthora cryptogaea* Pethyb. & Lafferty (var. *Richardiae* Buis.) since the differences between the Calla fungus and *Ph. cryptogaea* are mainly quantitative with respect to size of sporangia and oogonia and since recent work on *Phytophthora* has shown wide variation in size of these organs within the same species. It is of more than passing interest to record that this disease has just been reported (since this manuscript was prepared) by Weiss from America (4). Weiss notes its occurrence in New York, New Jersey, and probably in California.

Turning to the question of control, it is very satisfying to note that Buisman found that formalin treatment was effective in control, and her method was essentially followed with satisfactory results by Salmon and Ware. This method was recommended to the propagator at Martha's Vineyard and the developments fulfilled expectations. The technique is as follows: The corms are taken from the soil and all rotted parts are excised. It is essential to cut back the roots rather severely, as the fungus is present in some cases in apparently healthy roots. The corms are washed thoroughly in running water and then soaked for one hour in a weak solution of formalin (one part commercial formalin to fifty parts water). Fresh pots and uncontaminated soil are employed in repottimg the corms, and effective disposition is made of all contaminated soil and other waste from the plants. The pots formerly containing the diseased plants may be rendered safe for use by washing in a 1:20 formalin solution or by baking in an oven.

In January of this year every one of the one hundred plants in the greenhouse mentioned above was found to be affected, and they showed hardly a single marketable blossom. At this time the diseased parts were excised and the corms treated with formalin as indicated above. In

spite of the setback attendant on cutting back the roots and repotting at the height of the blossoming period, four months later the disease had been materially reduced and the plants bore numerous healthy blossoms. The propagator, who in January was at the point of discontinuing the rearing of the Calla, was entirely optimistic regarding their culture at the end of the four month period following the formalin treatment.

Weiss does not give specific data with regard to the use of formalin as a disinfective measure, but his experiments with chemical agents, particularly soaking the corms in 1:1000 mercuric chloride solutions, were followed by indifferent results thus far. However his experiments are being continued.

The *Phytophthora* disease of the Calla, as far as is known, has not been reported in America previous to this year, and it is important to discover the possible source of the disease. As to the infection reported here from Massachusetts, it is known that the diseased corms were purchased from a large wholesale importing firm. Since many of our corms are brought in from Europe, it is reasonable to suspect that the disease was brought to America in shipments from Europe. Weiss' observations and those reported above show that the disease is already distributed in the East. I have had occasion to be in contact with the Boston flower market for a number of years, and during that time no indication of the disease as manifested through scarcity of good blossoms has come to my attention. With the knowledge of the strong possibility of the epidemic spread of diseases caused by *Phytophthora* of whatever species, the recognition and the eradication of the Calla disease are earnestly recommended before it increases to unwieldy proportions.

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A PLANT COLLECTOR'S NOTES ON THE NEW HEBRIDES AND SANTA CRUZ ISLANDS[1]

S. FRANK KAJEWSKI

I left Sydney on the 1st February, arriving at Vila on the 11th, calling at Lord Howe Island and Norfolk Island en route. The first glimpse I got of Vila Harbour was very pretty and I was struck by the fresh vivid green of the foliage flanking the different colored coral waters of the harbor. To this the little town of Vila presents a strong contrast, as it consists of a row of squalid buildings in the main street which does not look very pleasing. There is no sanitation, water, electric light or other conveniences. Mosquitoes are bred plentifully in the empty tins lying around, the food of the inhabitants like in most tropical towns consisting largely of canned goods.

There is no decent hotel, as the one existing before was sold to the Condominion Government to be made into a lands office. The only other hotel is a small French one, which caters for all classes and colors. Plenty of bars, little evil places, built after the style of a small kiosk, many of them unregistered, sell alcoholic drinks to all classes and colors. The liquor is amazingly cheap, as there is a very small custom duty on it.

The Government is a joint dual control of England and France, which is not satisfactory to either party. Earthquake shocks or tremors are often felt, but as a rule do very little damage. There are three active volcanoes in the group, on the islands of Tanna, Ambrim and Lopevi.

From Vila the first island visited southwards was Erromanga, which is a remarkable island in many respects. This island has an elevated grassed plateau about 900 to 1200 feet above sea level and on this plateau an Australian gentleman, Mr. Martin, has a sheep station. It is a wonderful thing to see sheep doing so well in the tropics. On this plateau can be seen old coral formations everywhere on the surface. The coral is in a wonderful state of preservation, many different types being recognizable, also coral boulders, referred to throughout the islands as niggers heads. This proves conclusively, that a shelf of the sea was upraised by a volcanic disturbance.

The area of the grassed plateau is not very large and only occupies a small part of the island. The natives on this island in the early days were very savage and treacherous, having the reputation of being the fiercest of the whole of the natives of the New Hebrides. Altogether they killed four missionaries, but I think it was through their mistrust

[1] Mr. S. F. Kajewski collected for the Arnold Arboretum from Feb. 11, 1928, to March 20, 1929, in the New Hebrides and on Vanikoro of the Santa Cruz Islands. The following summer and autumn he spent in North Queensland collecting, and after regaining there his health which had been impaired by fever while in the New Hebrides, he went to the Solomon Islands where he is now continuing his work for the Arboretum. The plants collected in the New Hebrides are being determined by Dr. A. Guillaumin of Paris and partly by specialists; of this collection we expect to publish an enumeration in this Journal some time next year.—Eds.

of all white men at that time, as the sandalwood traders and blackbirders were cruel and inhuman in their treatment to the natives.

Erromanga has no harbors and the only anchorages are bays on the leeward side of the prevailing wind. The anchorage where I stayed at Dillons Bay is very pretty. The Williams River flows through a gorge over 700 feet deep, with a luxuriant rain forest growth down the sides and in the bottom. This coupled with the very clear waters of the river makes a beautiful sight indeed. Mr. Rae, the Presbyterian missionary there, was very kind, supplying me with boys and giving me every possible assistance.

Although a small island it has four distinct classes of soil distribution. The first is the tropical rain forest which is the same throughout all the islands, since close to the sea the strand flora is much the same. This type of rain forest is usually never very high, as cyclones, strong trade winds and its continual destruction by the natives in the past for gardens, have spoiled the conditions necessary for a tall rain forest.

The next formation on Erromanga is at 700 to 800 feet above sea level, which is of coral formation with coral boulders projecting everywhere. This is beautifully grassed and is open pasture country, with numerous ravines and well grassed steep hills. Clumps of Wattle (Mori) are growing everywhere, the Wattle being closely allied to *Acacia Cunninghamii*. The only drawback is that on account of the good soil and high rainfall, the grass tends to grow too rank and a growth of from 60 to 80 centimetres is quite common with sheep grazing over it all the time. Where sheep have no access the height is much greater running well over a metre. The sheep keep in excellent condition, many being sold locally in the islands for mutton, while the wool realizes good prices. The annual rainfall of the Island is over 70 inches.

The next formation is a little higher, 800 to 1500 feet, and consist of poor red clay soil, which marks the end of the coral formation. This formation is undoubtedly much older than the coral formation and like on all poor soil, bracken is very plentiful. The soil seems to be very porous and the leaves of the smaller trees and shrubs are thick, tough and have a dull color, evidently an adaptation of the plants to hold their own against the dry porous nature of the soil.

The last formation is the elevated rain forest on the slopes of mountains and small elevated plateaus. This contains many forms common in the coastal rain forests, but also has many trees peculiar to its elevation, which are quite large and of good proportions. In fact, the tallest trees are found on this area, the soil being very rich, mainly red or chocolate colored. Kauri Pine trees occur in this belt in ones and twos, but they are not common.

Seeing that the natives have a number of plants that they use for poisoning fish, I was determined to test the efficiency of these poisons. Taking my boys with me, we crossed to a place where some holes in the

reef had been left full of salt water after the tide had gone out. They went into the bush and cut bundles of a vine that was growing close by and brought them to the edge of the pool. I found out that they use a number of plants for this purpose and I have marked on the label every plant that I know is used for this purpose. With a stone each man beat the pieces of vines into shreds, and kept beating and soaking them alternately. When a bundle of crushed vine is put in the water, it quickly changes the color of the water in the vicinity to a milky color.

As the pool was of a large size about 56 lbs. of vine was used, some of it as thick as a man's wrist, others being much smaller. A small leguminous plant was also used in a similar manner.

After a quantity of the vines had been added the water became very cloudy and the fish came to the surface and darted aimlessly about. I saw several fish swim and leap right out of the water to get away from the substance that was poisoning them and lie struggling on the coral, being easily picked up by hand. Others sink to the bottom without coming to the surface as is popularly supposed. Some float and swim aimlessly about and are easily speared or shot with bow and arrow. The natives tell me that a good many die and remain hidden in the coral ledges under the water. When I asked them why they did not dive into the water for the fishes, they said it was bad for the eyes. I could not persuade any of them to jump into the pool, so I cannot say whether the water has any bad effect on human beings.

Erromanga has been noted for the quality and quantity of the sandalwood exported from its shores. Many lives were lost by both white and black and much suffering and misery caused through it. The natives have for generations used the sandalwood along with any other wood for firewood and had no idea of its value until the foreigners came and asked for the wood. The only price at first given for a big boat load of wood was a small piece of hoop iron three to four inches long, which was greatly prized by the natives since they only had stone axes.

Very often a rascally sandalwood trader would get his ship filled by showing all kinds of articles for barter and when his ship was filled with wood, would clap on all sail and go away laughing, giving the natives nothing. It is no wonder that the natives were so ferocious and bitter against the white man. Many innocents suffered including two missionaries, one missionary and his wife and one assistant missionary. Many other white men, rough diamonds of that period, no doubt also perished, besides numerous natives, often shot for little reason.

From 1820 to 1870 $875,000 worth of sandalwood was gathered, and that figure would be tremendously increased at present prices. There is very little sandalwood left on the island and that is inaccessible. The natives are now carrying the wood on their backs 15 miles to the nearest trader. The reason why any sandalwood is left at all, is that the wood must be very old to be of any value, as the older the wood the higher the

content of oil. As the trees flower when they are about seven years old, a small quantity have survived. The seeds do not seem to carry well and fail to germinate away from their own island.

From Erromanga the next island south is Tanna and I was there the guest of Mr. Nicol, the district agent. The native population is fairly large being about six thousand and Mr. Nicol takes a genuine interest in the natives, and this is one of the few islands where the population is increasing. Mr. Nicol rules with a fearless hand, suppressing grog and silly customs that are against the principles of civilization. Tanna has an active volcano which erupts regularly every three minutes and you can look for a cloud of smoke after these intervals. Of course sometimes it is much quieter than at others, but the periods remain the same. Captain Cook noted this particularity when voyaging down the coast and it has remained so to this day. Such an island is naturally very fertile, as it is continually getting a rich dressing of volcanic ashes, and marvelous crops are grown with very little cultivation.

The rain forest is thick but not very tall, one peculiarity I noticed was the absence of Lawyer vines, *Calamus sp.* The most conspicuous fact in the flora of Tanna is the marvelous number of different kinds of Figs growing there, from noble Banyans, that cover upwards to an acre, to a small one that does not grow more than three metres high.

I must say a little here about native superstition, which fifty years of missionaring has not stamped out. Quite recently after an epidemic of measles and dysentery, which caused many deaths, the natives were suspicious of some one causing all the mischief and accordingly set to work to trace the author. Consequently every day they held meetings and heard what witnesses had to say, and like a chain they kept dragging fresh persons into it, in a manner similar to a political scandal. All the happenings of the island for a number of years were recalled and memories had to work overtime to deny or assert facts. Practically the whole male population was represented as I saw many bushmen or heathen, with long plaits of bushy hair and almost nude. They were very fine men physically, most of them being six feet in height.

It is a very fine sight to see a crowd of eight hiundred natives, all men, seated on the grass and one man at a time talking. As there are four different languages on Tanna there are some men translating all the time. When one man has finished, one man of the opposing side gets up to contradict what he said and so the proceedings go on for days. Personally I think the men enjoy it as it is a welcome break in their lives, since they have not too much to do, making their wives do all the work. It must be interesting how they record the evidence as there are no shorthand writers, but the decision of the chiefs is final.

The next place we passed on to was Aneityum, the most southerly island of the group and having the distinction of being the first one of the group to be settled by missionaries. The first glimpse one gets of

Aneityum is very pretty and the wonderful harbor flanked by the coral and different colored waters is indeed beautiful. One does not get a good impression of the timber wealth of the island as the Kauri tops are not silhouetted against the skyline like at Vanikoro. Instead one sees a succession of poor red soil ridges, that lead up to the higher rain-forest hills and mountains, where the Kauri pine is found.

These red soil ridges are covered with Bracken and stunted shrubs, the soil being very poor. It seems to have been red mud spouted out of geysers and assumed a gravel-like texture, being very porous. It covers quite a large area of the island which differs in this respect from Vanikoro, where there is only a small proportion of waste land not covered by Kauri.

The climate of Aneityum is decidedly cool compared with the other islands, the temperature in the hot season staying between 75 and 90 degrees all the time, going down to 75 only at night.

There is a striking similarity of the vegetation of Vanikoro and Aneityum in regards to ferns and small trees. Both islands in addition to the flora of the tropical coral formation islands have a flora much older and distinctly different, growing on the red volcanic soil hills, including the wonder trees of the Pacific, the Kauri. In addition a *Podocarpus* found in the Eastern Malay Archipelago is also found there. Aneityum has not as many Orchids as Vanikoro, owing to the lower rainfall and cooler climate.

The Kauri on Aneityum (*Agathis obtusa* Mast.) seems to be very similar to that on Vanikoro (*Agathis macrophylla* Mast.). On Aneityum I think there are more species of commercial timbers than on Vanikoro.

The native population is fast decreasing owing to a variety of causes. The Aneityumese are a much lighter skinned race than the rest of the natives of the New Hebrides and are a pleasure loving crowd always laughing. Only 250 natives remain today out of an estimated former population of six thousand people. The remains of a church is still standing on one side of the Island, that would accomodate two thousand people and even that, it is said, had been far too small.

The decrease had set in before the missionaries came, as there was a whaling station there and other traders visited the island in search of sandalwood. These men brought all kinds of diseases and the native had not the constitution to stand against them, consequently they melted away before their inroads. Happy Aneityumese, they bear no malice against the white man, who has been responsible for nearly wiping them out. The birthrate is lower than the death rate and has been so since records were kept by missionaries. The men are twice as numerous as the women and infantile mortality is very high, yet an orphan finds a number of people always willing to adopt it.

THE NORTHERN GROUP OF THE NEW HEBRIDES

The whole of the New Hebrides group lies between 10 degrees and 22 degrees and consequently within the tropics. The rain forest formation is

the same throughout the group, a species of Cottonwood (*Hibiscus*) being prominent everywhere. In fact, one can find the same trees common throughout the group.

The majority of the islands are very rugged, the mountains coming right down to the sea, consequently the area suitable for plantations is not great. Pockets of fertile soil have here and there been cleared and planted. Quite a lot of wild cocoanuts are gathered and made into copra by the natives and this is picked up by cutters and small schooners. The islands are very hot and humid and there is only an appreciable difference when the trade winds blow and the sun is on the other side of the equator.

I went to the most northern islands of the whole group, the Banks Group and stayed at the largest island Vanua Lava. The Banks are the wettest islands in the whole group, the annual rainfall being over 200 inches. One of the flowering plants was a pretty *Begonia* which climbed well up the trees and was one of the prettiest there.

There is a good lot of Mangrove on the eastern side of the islands and nowhere have I seen mosquitoes so bad. The anopheles are in droves and when walking along the beach and an empty or hollow log is tapped, the mosquitoes come out in a cloud. It was on this island that I had the misfortune to contract fever very badly and I would have been sent to a hospital only there was no means of getting me there.

I must tell of the sulphur desposits of Vanua Lava which I visited before I was sick. These deposits on Vanua Lava are a splendid spectacle of volcanic formation and are well worth the trouble of getting to them. You leave a small bay at Langnetack and walk through about five miles of tropical scrub, crossing a river of sulphurous water aptly named Sulphur River, in which the water has a decidedly yellow tinge. The water is steaming all the time, giving off the familiar but strong smell of the sulphur compounds. The water is so hot that all the human skin can bear is to place the arms in it.

To get to the sulphur deposits you leave the river and take a short cut through the scrub, which consists of a luxurious vegetation, being in no way affected by the sulphur. After about three miles, without any warning, you come across a big cleft in between two hills, with a stream of hot blue water running through the bottom. On one side the scrub comes right down to the water's edge without any loss in luxuriance, while on the other side the ground is of a gray ashy color all smoking with sulphur fumes. Here and there are bright yellow patches of pure sulphur, while further up on the crest of the hill are numerous stunted trees of a *Eugenia* which seems to be found throughout the islands in a stunted form under adverse conditions. The same tree in the rain forest assumes mighty dimensions. There are also *Pandanus* trees and it seems very strange that these two members of the plant world should grow in soil that is exceptionally hot. I went through the crust of the soil at the base of one stunted *Eugenia*, burning my feet in the hot molten soil and the

tree was still alive although it showed signs of not having much life ahead of it.

The traveler has to be very wary where he places his feet as in many places there is only a thin crust on the molten lava and if this is broken the foot sinks into it and one could be very severely burnt before being able to extricate the foot.

The golden yellow deposits of sulphur is what takes the eye, as they are there in yellow pinnacles of all shapes and sizes, with the sulphur fumes rising thickly around, sometimes obscuring them and causing an uncanny mystic sensation. Under such conditions one is loth to break the top off of one of these pinnacles but when this is done, a slight report followed by a cloud of sulphurous steam gives a great shock to the breaker as he imagines he is letting off the pent up gases of the interior to wreck havoc and destruction.

Further on is a circular pool where the water is boiling with tremendous energy, the steaming blue sulphurous water being dashed round and round.

By this time the traveler has had enough of the dense sulphurous fumes, having a very severe headache and after breaking off a few pieces of sulphur is glad to set off for home watching his step as he does so.

VANIKORO, SANTA CRUZ ISLANDS

Vanikoro is the southern port of the Solomon Islands and is unique in respect of the stand of Kauri Pine there. The rainfall is exceedingly heavy, the gorge at the port being a very fine example of tropical luxuriance, which surpasses anything seen in the New Hebrides. The trees are draped with epiphytes comprising climbers, Ferns, Lycopods and the common long trailing Orchids of the tropics. The soil is brownish red and seems to be of a very great age. The absence of coral formations on the hills confirms this theory.

The Vanikoro Timber Company have carried out great improvements for the transport of timber to the sea. The rainfall is so heavy that the use of mechanical transport is impossible, except where there are railroad lines laid down. The Company have a tramline about one mile long into the foothills and use steam haulers with long wire ropes to haul the logs to the head of the tramline. The logs make deep furrows and on account of the heavy rainfall, a greasy surface is always present, which makes the hauling much easier than on dry soil.

The Kauri Pine has a very large head of branches and an exceedingly short trunk in comparison. On account of this a lot of timber is wasted as there are numerous branches on otherwise good logs. Sapwood is very considerable and proves that the Kauri is a fairly quick growing timber.

The trees bear large crops of cones and I have seen the heads white with large crops of cones in all stages, from the flowering stage to the cones that are bursting. A plentiful supply of seed is always available but only one in a hundred thousand germinates according to a rough

calculation made by me. Out of that one, only a fraction comes to maturity. The darkness caused by the overhead canopy of vines and leaves of the rain forest, together with the excessive dampness destroys the seeds and it is only when a seed lands on a well lighted piece of ground and gets favorable conditions that it germinates. In places it is very difficult to find small trees although there are numerous large trees about. This is one of the outstanding features of the islands.

The Lycopods of Vanikoro are very interesting. Nowhere else have I seen such a variety growing on the trees. These beautiful draping plants in my opinion give the trees a curtain effect. The number of varieties found here are astonishing being the richest island I have come across in this respect. The same applies to Orchids and other epiphytic plants.

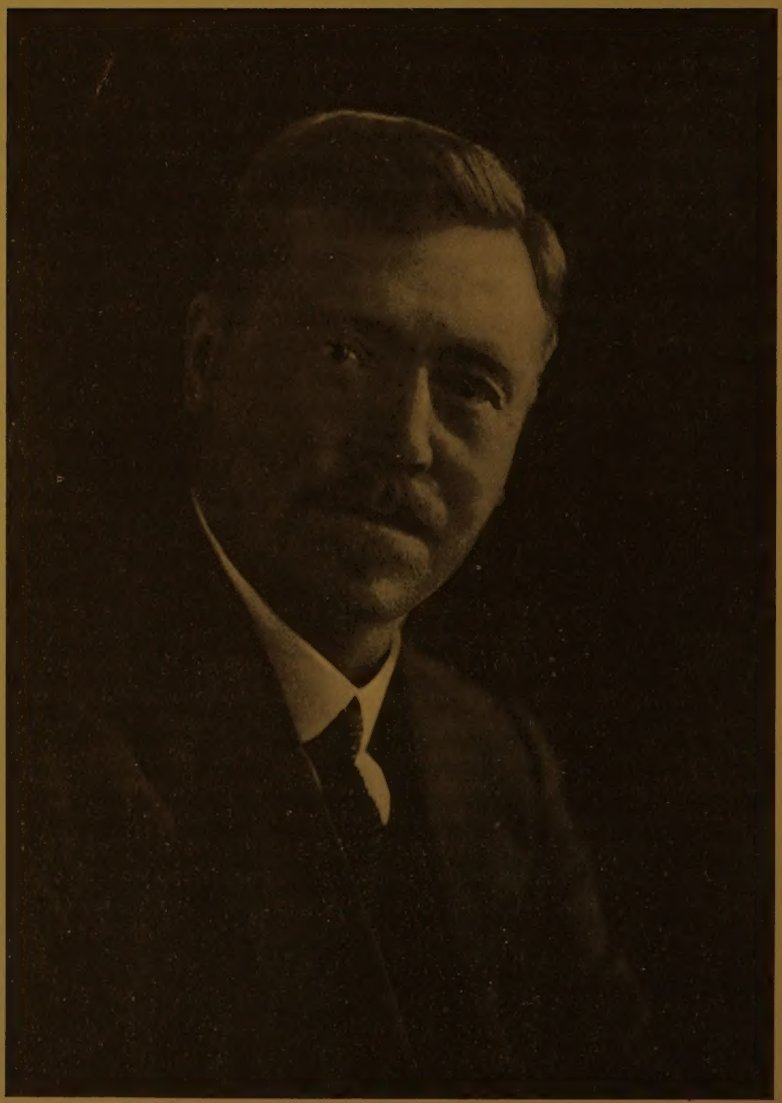
The flora of Vanikoro is the richest I have seen on a single island and the great variety of all classes of plants is amazing. The mosses on the tops of mountains are very grand making the trunks of the small trees look like gigantic pillars. These mosses all grow one length, about 7 inches long, and radiating out from the tree all around, give a wonderful pillar effect, like the ruins of an old Roman temple. A very pretty Orchid with a flower as large as the rest of the plant, was found growing out of the moss. It was found in two colors, white and pink.

Before finishing I must mention the Narli Nut or Ni, as this valuable nut is found right through the islands and is a valuable source of food supply for the natives. Nowhere are the trees as prolific as at Vanikoro, nor do they have the same long fruiting period. The nut is from 6 to 8 cm. long and 3.5 to 4.5 wide and about 3 cm. across, flattened on one side, with a slight round curve and going to an angle on the other side. An average kernel is about 5 cm. long, 3 cm. wide and 1.5 cm. across, but a good many are much larger. The cotyledons are well formed and constitute almost the entire kernel. These nuts have a flavor of their own, but one has to get used to them as they are very rich in oil. It is noticeable how fat the natives are, where this food forms one of their chief diets.

The trees bear exceedingly heavy crops of nuts up to ten being counted on a single fruiting stem, in fact so heavy are the crops that the branches are well bent down with the weight. They are covered with a purple black husk when ripe. The trees are exceedingly handsome and the bark exudes a high turpentine smelling gum. For economic and ornamental reasons, the trees should be planted in tropical and warm temperate climates.

There is a very interesting plant that grows right through the New Hebrides, being the native Arrowroot. This is typical of the large variety of plants that grow wild with very little attention. The tubers are not very large, being of the same size as the English potato, but they grow much larger in cultivation. One or two bulbs are found growing on a single plant, never more. This plant seeds very freely, one plant producing large quantities of seed.

The arrowroot is prepared in the same manner as that from *Canna edulis* and has a good reputation, being of excellent quality. The missions have raised sums of money by getting the natives to collect and manufacture it. The natives did not use it in any way before the white men came and even now do not manufacture arrowroot unless under white supervision. They can get plenty of other food without going to so much trouble. I sent seeds of this plant to the California Botanic Gardens.



E. H. Wilson